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USSR Report

ENERGY

(FOUO 8/80)

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ELECTRIC POWER

UPDATE ON CURRENT HYDROELECTRIC POWER CONSTRUCTION PROJECTS

Moscow GIDROTEKHNICHESKOYE STROITEL'STVO in Russian No 3, Mar 80 p 48

["Excerpts" from the section "Chronicle of Construction, Planning and Operation"]

[Excerpts] In the first ten day period of January, 1980, a link-up was made between the eighth and ninth excavations of the Arpa-Sevan tunnel. The blast which connected these sites proved to be the last in the construction of the 48-km long tunnel.

The tunnel mentioned above was built in order to feed Lake Sevan, one of the world's largest fresh-water lakes. The route for the builders was arduous and complicated, but the operations at the ninth excavation proved to be the most difficult. It passed through the zone of a gigantic tectonic fault full of water-saturated sedimentary rock. Large rock slides and underground water had to be overcome through the heroic labors of the tunnelers.

Approximately 1 million m^3 of rock had to be removed along the entire length of the tunnel, 250,000 m^3 of concrete and reinforced concrete have been poured and block elements and tubbing frames have been put in. Unparalleled courage, daring and valor have been shown by the best of the best at the construction site--G. Mirzoyan and A. Kazaryan, team leaders of the combined collective; tunnelers G. Tereshchenko, B. Chuchva, V. Svistun and V. Shvetsov; blaster A. Yeritsyan; underground surveyor S. Bagdarasyan; shaft foremen Yu. Mkrtchyan and R. Aristakesyan and many others.

During the construction process there arose many new problems associated with the great length and depth of the underground mains. All the problems were solved successfully. The study and generalization of this experience will make it possible to apply it on other underground mainlines.

The builders have fully completed 31 km of the tunnel, while a number of operations still have to be carried out on the remaining 17 km.

People of 16 nationalities from all corners of our great country are laboring on this path of courage in order to put the tunnel into permanent operation by the 60th anniversary of the establishment of Soviet rule in Armenia. In the remaining months they have to concrete-in the tunnel's roof and attach its floor in the deep No 9 excavation.

News that the link-up had occurred spread like lightning through the shafts of the Verdenis range. A celebration rally of the builders took place.

The widening of the Kegums GES on the Daugava river has been completed. The increase in its output holds great significance for the normal operation of the country's entire northwest power system. Work on the utilization of the Daugava's power resources is continuing. In eastern Latvia the construction of a new large-scale hydraulic power system has begun--the Daugavpils GES. Construction operations here are being carried out precisely on schedule. In 1980 the volume of work will double in comparison with the current year.

In the beginning of January, 1980, construction was begun on the Baypazinskaya GES. This hydroelectric station, located on the Vakhsha in Tadzhikistan, downstream from the Nurek GES, is the counterrace for the Nurek station. This station, the fifth of those in operation in the cascade, is being built in a hydraulic irrigation intake system. A dam is being erected, an underground conduit is being built and the GES building and take-off channel are under construction. Four generating units of 150.000 kW capacity each will be installed in the hydroelectric station. Construction of the station has been entrusted to the experienced builders collective of the Nurek GES.

In Yakutiya, almost in the center of the Verkhoyansk rayon, a project survey expedition of the Leningrad branch of the "Gidroproyekt" Institute has begun its work. The construction of the Nizhne-Adychanskaya GES is planned in this region. Drilling equipment and mobile powerplants have been delivered from the settlement of Batagay along the winter road and by air. Drilling began from the river ice and samples of the rock in the dam's foundation were analyzed.

The Spandaryanskoye reservoir, which will contain about 280 million m^3 of water, is being constructed in Armenia at an altitude of 2.100 m above sea level. Water from the 8 km delivery conduit will be discharged into the turbines of the hydroelectric power station which will produce annually about 160,000 kWh on the average.

In the first days of January, 1980, machine operators from the mechanized operations administration and drivers from the Motor Transport Column No 2 of Krasnoyarskgesstroy completed pouring the cofferdam for the local excavation pit of the Mayna GES. They have made it possible to proceed with construction of the left-bank retaining walls and the building site. Drillers and blasters from the blast-hole drilling division arrived at the construction site. It is assumed that in March workers will proceed with the pouring of the first concrete in the hydraulic power system.

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ELECTRIC POWER

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IMPROVEMENT OF THE LONG-RANGE PLANNING OF AES CONSTRUCTION

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 3, Mar 80 pp 20-22

[Article by M. M. Solov'yev, candidate of technical sciences]

[Text] An extensive program of AES construction has now been developed and is being implemented. It envisages the construction of nuclear power plants with a power of 4000-6000 MW, with water-moderated water-cooled power reactors (VVER) and RGMK reactors [not further identified] with a unit power of 1000 and 5000 MW. In the Tenth and Eleventh Five-Year Plans capacities are to be introduced and construction work is to be completed on more than 10 AES: the Kurskaya, Smolenskaya, Chernobylskaya (RBMK), Yuzhno-Ukrainskaya, Rovenskaya, Kalininskaya (VVER), etc [1]. A considerable number of power units with a power of 1000 MW or more will be constructed.

One of the major problems is improvement of the long-range planning of AES construction on the whole in accordance with the general plans for the development of power systems. In that case it is necessary to take into consideration the state of construction that had formed by the moment the planning calculations were made, and also the control plan figures for a period of 10-15 years for AES of all types. Such a complex approach permits analyzing in advance, preparing and adopting a number of effective administrative decisions on the coordination of the AES construction periods and rates, the volumes and structure of the introduction of capacities and the centralized disposition of the assuring production.

Planning decisions are prepared with the use of methods and means of machine modeling of long-range construction programs using models in planning power engineering construction [2-8]. In the present work the following complexes are examined:

1. The solution of problems of long-range planning of volumes of construction and installation work and the introduction of power capacities at AES during different rhythms of energy unit turnovers and standards of productivity of AES construction with consideration of the influence of interstation flows on them, limitations on the capacity of the main equipment,

the volumes of reserve stocks, the uniformity of introductions of capacity in power systems, etc. Taken into account in the calculations are the volumes of construction and installation work done in industrial, housing and social-public construction, and also labor resources of general construction, heat and electrical installation work.

2. The solution of problems in the disposition and development of assuring production (including specialized metal structures, reinforced panels and reinforced-concrete units). In planning calculations the quantity, locations, rates of increase of production capacities are determined by years of construction of new and reconstructed enterprises, the attachment of users and schedules of the transport of articles from enterprises to AES construction sites.

The two complexes are interconnected. The solution of problems of the first complex precedes the solution of problems of the second and its result (the plan for introductions of capacities) is the basis for determining measures taken in the selection of the locations of producer-plants and plans for the deliveries of materials. In turn the results of the solution of the complex of problems in providing resources* serve as additional arguments in a comparative analysis of alternatives of the plan designated in the solution of the first complex.

To prepare and make planning calculations, four stages that combine those complexes are characteristic:

--technological substantiation of resources and the formation of a normative base (for the two complexes);

--making optimized computer calculations of plan alternatives (problems of the first complex);

--development of recommendations according to the results of analysis of plan alternatives;

--organization of the provision of resources (problems of the second complex).

The results of technological substantiation are the basis for making further calculations, analysis and the development of recommendations on the adoption of planning solutions. And in the process of making calculations and analysis of the obtained results of the obtained data the technological substantiation of new alternatives of planning and organizational solutions is accomplished.

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*It should be emphasized that in the present article a limited range of problems of supplying resources is examined; this is connected with the specifics of production of special metal structures, reinforced panels and reinforced-concrete units for AES.

[redacted]

In the stage of technological substantiation of calculations, alternative consolidated grid schedules of construction and installation work on the main facilities and structures are compiled and calculated (primarily for the apparatus sections and the main buildings). The labor expenditures are estimated from the data on the construction of the main power units (with improvement of the construction technology and growth of labor productivity taken into account). Also examined are the necessary rates of overtaking construction of housing settlement, annual (for years of AES construction) requirements for housing area and volumes of construction and installation work done on housing and social-public construction objects. In that case the numbers of population of a settlement are determined with consideration of the number of operating and servicing personnel, and also the corresponding city-forming coefficients. In the technological substantiation of alternatives in the disposition and development, adopted design solutions are taken into account (including the mass and dimensions ~~of~~ structures), as is the specialization of existing enterprises, and the possibility of disposition of new enterprises, the methods of delivery of structures to AES construction sites, etc, are determined.

In making a series of optimization calculations of different plan alternatives by computer and in selecting a certain limited number of alternatives of AES construction for further detailed analysis, comparison and development of recommendations, use is made of alternate distributions of volumes of construction and installation work obtained in the preceding stage of calculations and data connected with them with respect to the periods required for the introduction of capacities for each AES and the manpower needs. The table presents a model composition of the starting data for planning the construction of AES with a power of 6000 MW (6 x 1000 MW with a VVER-1000) during the introduction of power units with a spacing of 24 (12) months.

The software of optimization calculation includes a model of power engineering construction and a package of practical programs for the solution of integral problems of linear programming [2,3].

As a result of the second stage of optimization calculations a selection is made of three or four alternatives of the summary plan for the distribution of construction and installation work by years of construction and introduction of capacities. In the analysis of the influence of the volumes of construction by objects that go over into the reserve, machine calculations are made for a longer period that exceeds the planned period by 5-10 years.

The alternatives of summary construction plans obtained in that stage and a number of data calculated in the first stage of technological substantiation (the volumes of housing and social-public construction, the main types of work and manpower) are used in analyzing the plan alternatives and in developing recommendations on the selection of the length of AES construction, the spacing of the introduction of unit capacities, the unification of AES into interstation flows, etc (the third plan).

Indicator	Total	Years of construction					
		0	1st	2nd	3rd	4th	5th
Introduction of capacities, 1000 MW	6		-	-	-	-	1(1)
Volume of construction and installation work, %:							
industrial construction	100	-	3(3)	5(6)	6(11)	8(13)	8.5 (14.5)
housing and social-public construction	100	6.6(5)	12(17)	12(17)	10.6(16)	9.3(12)	9.3(9)
Numbers, %							
construction workers		9.5(5.5)	59(42)	83.4(64)	85.5(94)	100(95)	100(95)
operations workers		0.6(0.6)	2(2)	4(4)	5(5)	25(25)	49(49)
		6th	7th	8th	9th	10th	11th
Introduction of capacities, 1000 MW		(1)	1(1)	(1)	1(1)	(1)	1
Volume of construction and installation work, %:							
industrial construction		8.5 (14.5)	8.5 (14.5)	8.5(13)	8.5(8)	8(2)	8(0.5)
housing and social-public construction		6.6(8)	4.6(6)	4(4)	3(3)	2.6(2)	2.6(1)
Numbers, %							
construction workers		92.5(93)	86(87)	81(70)	78(22)	72(6)	68(2)
operations workers		54(61)	61(7)	64(80)	71(90)	73(100)	80(100)

Indicator	Years of construction				
	12th	13th	14th	15th	16th
Introduction of capacities, 1000 MW	-	1	-	1	-
Volume of construction and installation work, %					
industrial construction	7.5	6	4	1.5	0.5
housing and social-public construction	1.3	1.3	1.3	1.3	0.6
Numbers, %					
construction workers	65.5	46	20	7.5	2.5
operations workers	90	93	100	100	100

The software of the third stage includes a set of auxiliary machine programs for processing the enumerated data for each of the alternative plans. Sets of analytical indicators are formed on the basis of the results of the calculations for the economic evaluation of long-range programs of power engineering construction [8], the reduced capital investments (the volumes of construction and installation work), the volumes of incomplete construction (reserve), the change of the cost of construction and payments for fixed assets of construction organizations, the effect resulting from AES operation and expenditures in the non-productive sphere.

In addition, that set includes indicators characterizing the volume of housing and social-public construction, the number of electric power plants being constructed simultaneously, and total manpower requirements for the main types of work, that is general construction and heat and electrical engineering installations. Those indicators are calculated by years of construction, Five-Year Plans and the entire planned period.

Presented below are data of a comparative analysis of long-range programs of construction with various time intervals for the introduction of VVER-1000 energy units at each AES (12 and 24 months):

Volume of construction and installation work--industrial construction according to program as a whole (without reduction	100/105.2*
Maximum annual volume of construction and installation work on all AES	100/105.1
Maximum annual volume of construction and installation work per AES with a VVER-1000	100/56

*In the numerator, for an introduction interval of 12 months, in the denominator, of 24 months.

Maximum number of AES power units simultaneously under construction without taking reserve electric power plants	14/20
Total labor expenditures on program execution	100/104.5
Including on the following work:	
general construdtion	100/105.5
thermal installation	100/101.7
electrical installation	100/102
Volume of construction and installation work on housing and social-public construction	100/92.4
Economic indicators of the effectiveness of capital investments (with reduction taken into account):	
reduced capital investments	100/103.4
unfinished construction	100/196.4
payment for fixed assets	100/108.4
arrivals from operations	100/75.0
expenditures in the non-productive sphere	100/106.4
annual maximum summary expenses	100/120

As follows from those data, the reduction of the construction periods and the time spacings of the introduction of capacities at each AES site with a VVER-1000 to 12 months assure:

--reduction of the number of simultaneously constructed electric power plants by 42-45 percent, which in turn leads to reduction of the requirements for highly qualified engineering personnel, special-design structural mechanisms and machines, and also to improvement of conditions for conducting measures on the organization of work in the period of preparation of construction production and installation of the first units;

--favorable conditions for the organization of flows between stations; thus, for a 24-month rhythm of introduction of capacities it is possible to form three interstation flows for two AES with VVER-1000 reactors; the introduction of capacities at electric power plants erected by production line methods is being doubled and will amount to 64 percent of the total volume of capacities introduced at all AES with VVER-1000 reactors.

The presented data testify to considerable advantages in the curtailment of construction periods and the spacing of the introduction of capacities at AES under consgruction, which also corresponds to the general principle of increasing the effectiveness of the concentration of capital investments [7-9].

In the fourth stage in the considertion of questions regarding the providing of the long-range program with special and structural designs, equipment, basic materials, etc, used as the initial data are a number of normative data determined in the first stage of technological substantiation; for example, the distribution of requirements for reinforced panels and special metallic structures for AES erection by years, the regulations for freight transport by rail and waterways, specific expenditures on the development of production, transport operating conditions and plans for transportation to construction sites.

The software for that plan includes models and machine programs for the solution of dynamic programs in disposition and development, optimum freight shipment schedules, and auxiliary programs for processing initial data [5]. The optimization is accomplished according to the criterion of the minimum combined expenditures, the production of finished product and its transportation from producing plants to AES under construction.

By means of many computer calculations an analysis is being made of the influence of such factors as the limitation of the capacities of enterprises, uniformity of their loading, the method of transportation of articles, the number and geographic locations of production and the specialization of enterprises. Calculations have revealed the advantages of centralized manufacture of special structures under plant conditions on the basis of atomic energy construction combines (atomenergostroitel'nyy kombinat--AESK). Very good economic indicators can be obtained when four AESK specialized in the production of structures for each type of reactor have been constructed.

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ELECTRIC POWER

PROBLEMS WITH EQUIPMENT, QUALITY CONTROL FOR POWER PLANTS

Moscow VOPROSY EKONOMIKI in Russian No 2, Feb 80 pp 127-130

[Article by I. Sidanov and A. Zarnadze]

[Text] The orientation of production toward the final national economic results requires a new approach to determination of production of all participants in development of new equipment--from scientific research and planning institutes and design offices to the manufacturing plants and construction-installation and starting-adjusting organizations. The final national economic result of the unified "science-equipment-production" system is equipment, which provides the user with the planned level of technical-economic indicators from the day it is put into operation, that is, a previously determined socioeconomic effect. This approach to determination of the product of the "science-equipment-production" system makes it possible to establish the clear economic responsibility of all developers of the new equipment for its actual efficiency, to formulate the organizational boundaries of responsibility between the producers and users of the new equipment and to combine all its functional elements on an objective economic basis.

Analysis of the effectiveness of introducing new equipment in some sectors indicates that the actual efficiency of the introduced equipment is in many cases below that of existing equipment. Thus, energy equipment whose technical and economic indicators have for a long time not reached the design level and which are inferior to similar indicators of previous models, is frequently delivered to electrical power engineering. Assimilation of the planned technical and economic indicators of energy units with rating of 300 MW continued for 8-10 years. During the period from 1965 to 1972, energy units with rating of 300 MW operated with lower utilization factor of established power compared to the medium-sector level. Assimilation of the planned technical and economic indicators of these energy units was related to extensive technical, organizational and financial difficulties.

Analysis of introduction and use of energy blocks with rating of 300 MW showed that the average annual rates of growth of profits at electric power plants with these units was more than twofold higher than those at electric power plants with units of smaller capacity, but the absolute level of the profitability of energy units with rating of 300 MW remained below the level of that of energy units with lesser capacity. The specific fuel consumption in energy units with rating of 300 MW during 1964-1974, during the period of their intensive introduction, was greater than that in energy units with rating of 150 and 200 MW. Only in the early 1970s did the specific fuel consumption in these units begin to decrease intensively compared to the fuel consumption in energy units with rating of 150 and 200 MW.

The length of the deadlines for assimilating the planned technical and economic parameters was partially caused by the fact that they were separated from the real potential capabilities of achieving the level of technical and economic indicators of the new equipment. There are frequent cases when the planned technical and economic indicators are so exaggerated that it is essentially impossible to achieve them. This is explained by the fact that not a single one of the participants of step by step realization of the new equipment--planning organizations, manufacturing plants or construction-installation and starting-adjusting organizations--bear any economic responsibility whatever for realization of the planned technical and economic indicators. The actual efficiency of the new equipment does not attract the economic interests of its developers, but is reflected only in the economic effectiveness of the users. Moreover, financial funds for development of new equipment are not located either with the users or its developers. All the difficulties of development are placed on the users of new equipment, as a result of which expenditures for finishing and assimilation occupy a high specific weight in their capital investments.

According to the decree of the CPSU Central Committee and the USSR Council of Ministers "On improvement of planning and intensification of the effectiveness of the economic mechanism on increasing production efficiency and work quality," the indicator of the saving from implementation of scientific and technical measures will be confirmed in the section of the plan on introduction of new equipment. Thus, the saving from introduction of new equipment becomes and object of planning, which significantly increases the economic incentives of all the participants in development of the new equipment and rapid introduction of it. The conversion during the 11th Five-Year Plan of scientific research, planning-design and production organizations, provided by the decree, to a system of accounting for work completely finished and accepted by the customer will also contribute to this.

We feel that review of the economic content of the deadlines for assimilation and their role in the mechanism of introduction of new equipment would contribute to rapid assimilation of the planned technical and economic indicators. We feel that there is not need to maintain so-called normative deadlines for assimilation of new equipment. The existence of normative deadlines for assimilation of new equipment is justified before serial production of the new equipment, but not after it has been installed at the user's facilities, when the equipment should produce an additional socio-economic effect.

Equipment which has not even passed monitoring tests is sometimes delivered for operation. For example, a turbogenerator with rating of 500 MW was sent without monitoring tests and without control assembly to the Nazarovskaya GRES for installation. The low-frequency vibration inherent to superpowerful turbines appeared when the turbogenerator was put into operation. The manufacturing plant released the machine, not having fully assembled it; therefore, its prcperties could naturally not be studied. As a result during five years after being put into operation, the generator was shut down 62 timus due to serious damage and on the whole its idle time comprised almost three years.

Assimilation of new experimental models is of important significance at the stage of developing new equipment. Problems both of a technical and economic nature, for solutionof which long periods are required, occur during finishing of new equipment. Moreover, new equipment is finished under conditions of a definite scientific risk. The scientific risk in development of new equipment will be increased with development of science and technology. Time is also required to finish experimental models in order to provide the efficiency which would be higher than the actual efficiency of existing equipment when the new equipment is delivered to the user.

In many cases the deadline from the beginning of planning to conducting tests extends for 5-10 years, whereas the bonus for efficiency is paid only over a period of three years according to existing regulations. Especially great difficulties arise in those cases when developments should be approved at operating enterprises. Thus, the efficiency of new power engineering equipment can usually be established only after it is installed and put into operation at electric power plants. And if the conditions for the sequence and continuity of the entire "science-equipment-production" cycle are provided, the new equipment will produce the effect assigned to it.

However, these conditions are far from always provided in practice. For example, the Podol'sk Machine Building Plant imeni Ordzhonikidze manufactured all the boilers required for the Ryazanskaya GRES within the deadlines, but the first of them was not put into operation according to the plan. How can efficiency be evaluated under these conditions? There is no doubt that timely intoruction of the first models of the new equipment will create conditions to carry out finishing operations even before serial production of it begins. This makes it possible to accelerate introduction of new equipment and to provide the national economy with a significant saving.

It must be noted that the planned technical and economic indicators, which the basis for planning the efficiency of new equipment, should be corrected for real operating conditions of the new equipment. Only in this case will they become normative in their technical and economic content (let us conditionally call them planning-normative) and will reflect the potential capabilities of the new equipment. By comparing the achieved level of efficiency to the planning-normative value, production collectives will be able to determine the extent to which the new equipment is being utilized efficiently to increase labor productivity and to reduce materials consumption, stock consumption and product cost.

According to the method (main regulations) for determining the economic effectiveness of using new equipment, inventions and innovator proposals in the national economy, the main criterion for estimating the efficiency of new equipment is the annaul saving which represents the difference of the reduced expenditures by the version being compared. The national economy achieves this saving as a result of production and use of new equipment compared to that replaced. But it remains an economically "unrelatable" value for enterprises and is only potential in nature. Its value does not directly form the actual increase of national income from introduction of the new equipment, but indicates what saving the national economy will achieve under conditions of limited fund accumulation due to implementation of one or another version of a technical development compared to other versions.* However, if the national economic saving determined when selecting versions of new equipment is not reflected in the financial condition of specific enterprises, the economic indicators which form the reduced expenditures directly affect the saving of the users. Consequently, realization of the planning-normative indicators for the users means that the advantages of the new equipment are brought up to economic practice compared to the old equipment when calculated per unit of produced product.

The saving directly realized by the users will be greater or less as a function of the specific operating conditions of the new equipment, but the achieved saving should always correspond to the normative requirements of the coefficient of effectiveness of capital investments. In this case the normative coefficient will play the role of the lower bound not only of the planned but also the actual efficiency of the new equipment. Consequently, new equipment is that which creates the actual cost-accounting level of additional profits for the user with deduction of the payment for the basic funds, estimated by the coefficient of effectiveness of capital investments in new equipment. This approach makes it possible to estimate the effectiveness of replacing models of the new equipment from the viewpoint of its user saving. The planned technical and economic indicators acquire real economic meaning and will be related to the existing system of economic indicators.

It should be noted that the system of economic indicators for estimating production efficiency still does not fully orient enterprises toward the most rapid introduction of new equipment, since the contribution of the new equipment to the increase of production efficiency is inadequately taken into account in it. Not one of the existing economic indicators for estimating production efficiency reflects the level of using the potential

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* See "The Planned and Actual Saving of New Equipment" (V. G. Fel'zenbaum, chapter 10 in the book "Nauchno-tekhnicheskiy progress i ekonomika sotsializma" [Scientific and Technical Progress and the Economics of Socialism], Izdatel'stvo "Ekonomika", 1979, page 187).

capabilities of the new equipment during its functioning. The user enterprises do not keep a record and monitor the increase of the mass of profit, the increase of profitability, the increase of labor productivity and the reduction of the cost and production delays due to introduction of the new equipment. The system of economic indicators and its composition and structure should play an important role in acceleration of scientific and technical progress and implementation of its results in practice.

The effectiveness of the mechanism of economic control largely depends on the extent to which the entire activity of production collectives, their efforts and initiative in technical re-equipping of the plant and an increase of its efficiency are objectively reflected in the system of economic indicators. The profits and profitability indicators are related to the most important efficiency indicators in sectors of industry, but they do not reflect the specific conditions of the specific participation of a plant and the goal and task of operation of the new equipment and the technical level of production is difficult to judge by them.

These deficiencies of the profit and profitability indicators are especially obvious on the example of electric power engineering enterprises. The nature of power engineering production is not fully taken into account in them. Its specifics are such that economic indicators vary in different directions--both in the territorial and in the time profile--due to the effect of factors not dependent on production collectives. The factors which affect the level and dynamics of economic indicators in energy systems are related to the conditions of economical operation of power engineering equipment, the load conditions of users, the structure of the energy balance of energy systems, the structure of the energy users, the average selling rates of energy, hydrometeorological conditions, introduction of production capacities at energy users' facilities and putting distributing networks into operation. For example, electric energy will be converted to energy systems where thermal power plants predominate, the cost of energy development at which is considerably higher than at GES, during floods in regions with powerful hydroelectric power plants due to its low cost. Under these conditions even the most progressive thermal electric power plants in the technical sense will bear an incomplete load in the receiving energy system. Naturally, if the production capacities of thermal power plants are inadequately utilized, the production profitability in the energy system will drop, the cost will increase and the mass of profits will decrease and so on.

The foregoing indicates that production collectives are not fully capable of affecting the level of the actual efficiency of new equipment and cannot regulate the level of labor productivity, profitability and profits, since the degree of utilization of new equipment is determined by the loading conditions of the energy association as a whole. How are the unutilized reserves of new equipment estimated under these conditions? These problems cannot be solved in electric power engineering, as in other sectors of industry, by using the existing system of economic indicators. It is obvious that a way out must be sought in improving the methods and indicators of estimating the efficiency of using the new equipment.

We feel that the efficiency of using new equipment and the completeness of realizing its potential capabilities are rather clearly reflected in the production cost of the product. However, the cost of production must be compared to the planning-normative rather than to its planned value formed by the principle "from the achieved level."

6521
CSO: 1822

ELECTRIC POWER

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CONSTRUCTION OF SOLID-FUEL TETS

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 3, Mar 80 pp 2-7

[Article by engineers V. S. Varvarskiy, S. B. Grobokopatel', and P. S. Borozna]

[Text] As experience in the erection of series-produced TETs-ZIGM's [not further identified] has shown, the method of construction according to series standard plans has justified itself.

Envisaged in the TETs [TETs zavodskogo izgotovleniya na tverdom toplive--plant-manufactured solid-fuel TETs] plan, as in the TETs-ZIGM plan, is a combination of plans of standard components of the main structure (of constructively developed coded complex structural and technological sections), from which in the planning of a specific facility the plan is executed for the main structure of an electric power plant with the prescribed capacity in an arbitrary sequence of installation of the main technological equipment.

The designing of standard components, sub-assemblies and assembly units forming a part of the structural and technological sections assures:

-- a technological level of plant manufacture and installation of all structural components;

-- standardization of a large quantity of manufactured components and a series character of their manufacture;

-- preservation of the volume of finishing and preparatory work done in the process of construction and installation;

-- improvement of the structure of construction and installation work (through increase of the proportion of units and increase of the plant readiness of auxiliary equipment and structural designs arriving at the installation zone);

-- standardization of the technical documentation arriving at manufacturing plants and construction and installation trusts.

Experience in the introduction of the TETs-ZIGM plan has in practice confirmed the real possibility and advisability of such a principle of planning and erection of the main structures of electric power plants.

It should be noted, however, that development of the TETs-ZITT plan is complicated by difference of the physicochemical properties of units and need, connected with that, to apply boiler units of various types, differing in the design of the boiler-convective volumes and the schemes of dust preparation and dust trapping, and also by the absence of standardized solutions of boiler units made by different boilermaking plants.

Even when there is a plan of a standardized BKZ-420-140 (BKZ--Barnaul Boiler Plant) (PT-2 and PT-7) (PT--steam turbine) with a steam output of 420 tons/hr, developed by the BKZ and the TsKTI (Central Scientific Research, Planning and Design Boiler and Turbine Institute imeni I. I. Polzunov), with the participation of the VNIPIenergoprom (All-Union Scientific Research and Planning Institute of the Power Industry) and manufactured by the BKZ, the different physicochemical properties of the fuels leads to the need:

-- to create two modifications of that boiler, with solid (for the combustion of Azeyskiy and Raychikhinskiy brown coals) and liquid (for the combustion of Irsha-Borodinskiy and Nazarovskiy coals) slag disposal, different in the furnace chamber configuration and the arrangement of the burners;

-- for various dust preparation* systems (hence differences in the make-up of the boiler unit, the auxiliary equipment and the lay-out of the dust, gas and air ducts);

-- to install dust-catching equipment of various types.

Depending on the dust preparation system, three modifications of the sections have been developed (Table 1).

Taken as the basic equipment (by analogy with the TETs-ZIGM plan) were a standardized gas-tight boiler with a steam output of 420 tons/hr, the BKZ-420/140 (PT-2 and PT-7) and turbines of six types (the PT-80, PT-135, T-110, T-175, R-50 and R-100 for steam parameters of 14 MPa and 560°C).

To assure the possibility of repairing the boiler a cell width of 30 m is necessary, whereas the cell width of T-110, PT-80 and R-50 turbines is 24 m and of T-175, PT-135 and R-100 turbines is 48 m.

To preserve in the TETs-ZITT plan the principle of construction of structural and technological stations, without which the development of a series

*A promising lay-out of dust preparation with concentrated feeding of dust has been developed for boilers with liquid slag disposal and direct injection.

Table 1

Dust preparation system	Section components	Quantity*
With an intermediate bunker (for Irsha-Borodinskiy and Nazarovskiy coals) and liquid slag removal	Coal grinders MMT-1500/2590/130	2/2
	Forced-draft blowers	2/2
	Mill blowers	2/2
With direct injection (for Azeyskiy and Raychikhinskiy brown coals) and solid slag disposal	Coal grinders MMT-1599/2510/140	4/4
	Secondary air blowers	4/1
With the application of dust concentrators (for boilers with liquid slag disposal)	Mill blowers 2100/800/735	2/4
	Mill blowers MV-75/1200U	2/4
	Dust concentrators with 4 small dust extractors	2/4

*In the numerator is the number of dust preparation systems, and in the denominator the number of units of equipment.

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multiple-purpose plan is impossible, sections with turbines and a single boiler are made in two modifications--with 36-m cells for the odd station numbers of turbines and with 24-m cells for the even numbers. This permits in the arrangement of two sections with lengths of 36 and 24 m (a total length of 60 m) placing in them the cells of two boilers (also with a total length of 60 m).

The length of sections with the turbines T-135, T-175 and R-100 is assumed to be 60 m. The free areas in sections with lengths of 30 and 60 m are used for the installation of 6 and 0.4 kW distributors for their own needs and assemblies of control systems, and also for the distribution and repair of equipment of the machine room.

As a result of multivariant developments in the selection of the number and components of the structural and technological sections in the TETs-ZITT plan the following components and length of sections, in meters, are recommended, from which the main structure can be composed with any given set of turbine equipment:

Section with constant end	2 x 12 = 24
Section with variable end	1 x 12 = 12
Doborochnaya section [not further identified]	1 x 12 = 12
Peak-reserve boiler section	2 x 12 = 24
Boiler and turbine sections	
PT-80 (odd)	3 x 12 = 36
PT-80 (even)	2 x 12 = 24
T-110 (odd)	3 x 12 = 36
T-110 (even)	2 x 12 = 24
R-50 (odd)	3 x 12 = 36

PT-135	5 x 12 = 60
T-175	5 x 12 = 60
R-100	5 x 12 = 60

Depending on the modification of the boiler (PT-2 or PT-7) different dust preparation systems are used in the indicated sections.

In the section with a constant end are placed all the necessary technological equipment and operating services.

The section with a temporary end is intended for the distribution and maintenance of equipment in the period of observations. It can be used for the installation of thermomechanical equipment of the outer boiler and turbine section by industrial methods. The section also serves for the distribution and repair of equipment. The need to include the doborochnaya section in the lay-out of the main structure is determined as a function of the capacity of the TETs and the make-up of all the stations.

In the peak-reserve boiler section are boiler units and the boiler and oxidation-reduction installations.

In the boiler and turbine sections, besides the equipment (boilers and turbines), auxiliary equipment is installed which completely assures the working capability jointly with the equipment arranged in the section with the constant end and other production structures on the area of the TETs (the circulating pump area, the fuel equipment, etc).

The thermal systems of the TETs-ZITT main structure were developed with consideration of the possibility of using block diagrams, the steam output of the boilers and the steam requirements of the used turbines without violating the principle of construction of complex structural and technological sections. To observe those conditions, in the TETs plan with the PT-135, T-175 and R-100 turbines a double-unit scheme is used. In the development of the TETs plan with those turbines and the turbines PT-80, T-110 and R-50 a thermal scheme with simplified cross connections is envisaged.

When there is a peak-reserve boiler section in the main structure, in the circuit of each generator provision is made for the installation of a VGM-20 switch, through which the generator is connected to the unit step-up transformer. The transformer for the section's own needs is connected by a line with the power unit. Power is fed to a high-voltage network. To realize the possibilities of feeding power on generator voltage, turbogenerators with a power of 120 MW can be commutated on main distributor buses.

The lay-out of the TETs-ZITT main structure makes provision for the erection of a single-bay bunker-deaerator stack with a metallic shed in the boiler-room, and also delimitation of the zones of disposition of thermomechanical and electrical engineering equipment* (Fig 1), which permits:

--reducing the height of the stack;

--reducing the number of ceilings between stories to three;

--organizing the piping story at the 9.60-m marker, where most of the regulatory and support fitting will be installed, including ROU, BROU [not further identified] and fittings executed in the form of aggregated bulk units and an auxiliary deaerator;

--lowering the markers of the deaerator positions;

--renouncing the making of inefficient and labor-intensive hydraulically isolated monolithic reinforced concrete slabs on the roof above electrical equipment.

Switching and bussing equipment for station auxiliaries of 6 and 0.4 kW and also assemblies of valves of control and automation systems are arranged in the free bays of the machine room in the sections of turbines PT-80, T-110 and R-50 with a length of 36 m each and in the free bays of the sections of turbines PT-135, T-175 and R-100 with a length of 60 m each. For the more effective use of free areas of the machine room the ceilings above the switching and bussing arrangement supplying the station auxiliaries were constructed so that it is possible to accomplish on them the adjustment and repair of equipment of the machine room.

Such a lay-out permits accomplishing large-unit installtion of switching and bussing equipment for station auxiliaries by the overhead crane of the machine room, and later with the application of bulk units of plant manufacture combined with structural elements.

The removal of electrical equipment beyond the limits of the bunker-aerator stack makes it possible to improve its operating conditions (the need disappears for assurance of increased hermeticity of the surrounding structures), and also to arrange the piping, not on special stacks, but at the zero marker of the bunker-deaerator stack with the use of the main structure framework.

Renunciation of construction of piping along row A permits reducing the extent of the large-diameter piping (in the case of disposition of the peak hot-water boiler room in the direction of the dust pipe the main water pipelines can be laid directly through the boiler section toward the hot-water boiler room and free space for the installation of group and

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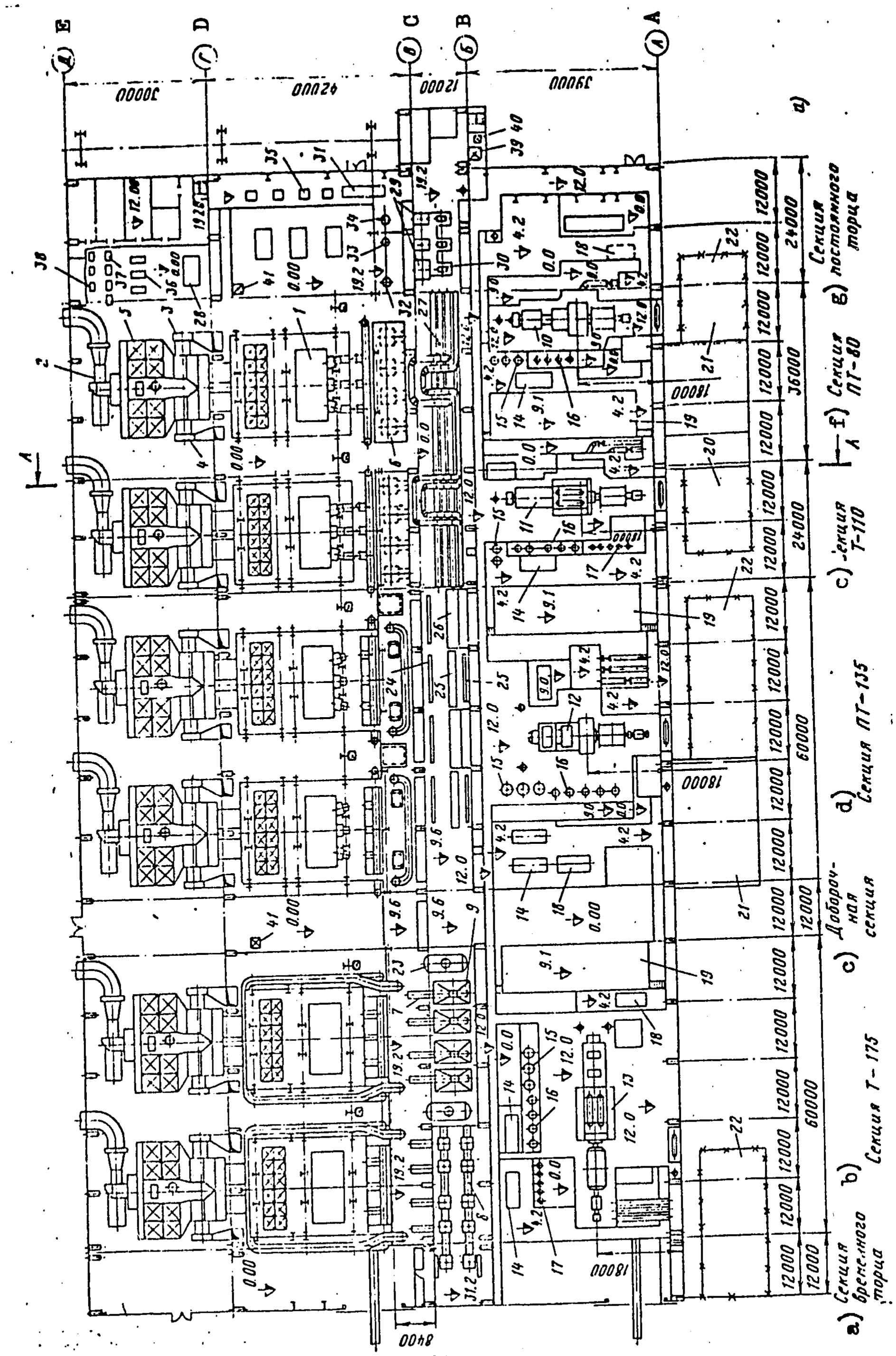
*In the TETS-GITT plan the lay-out of the electrical equipment was adapted with consideration of the lay-out developed by the Gor'kiy department of Teploelektroproyekt Institute in the plan of the main structure of the Kirovskaya TETs-5.


a) Секция временного торца
b) Секция T-175
c) Доборочная секция
d) Секция ПТ-135
c) Секция T-110
f) Секция ПТ-80
g) Секция постоянного торца

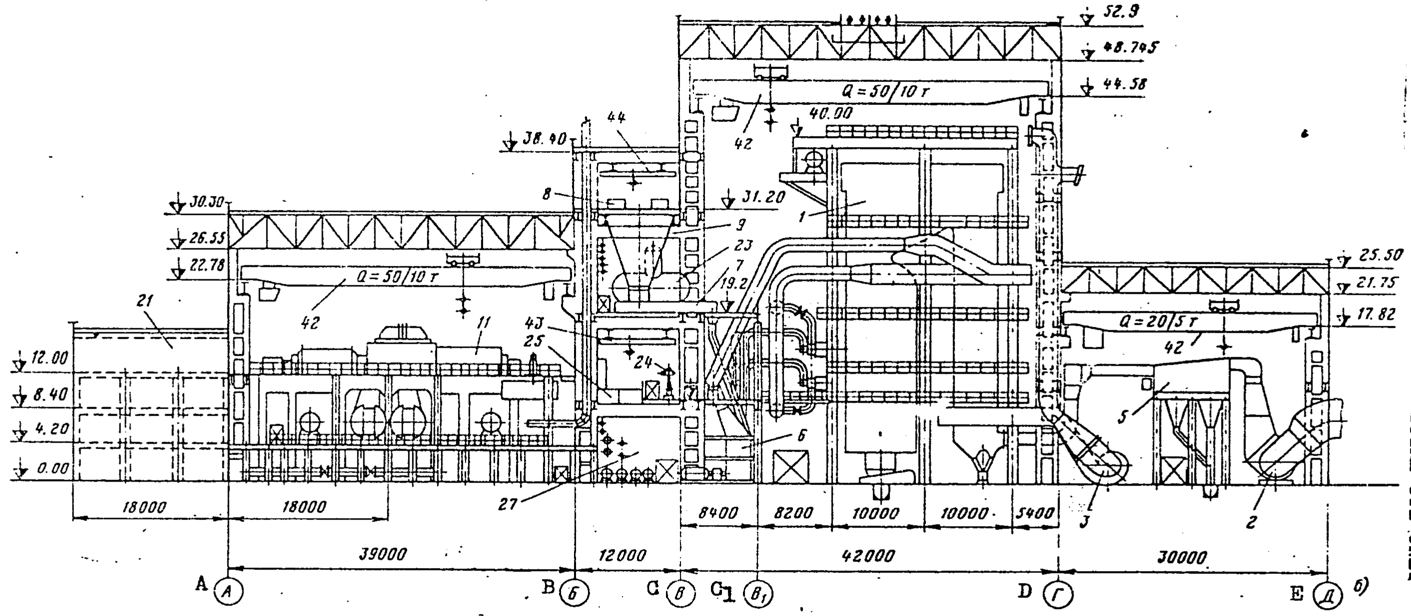


Fig 1. Example of lay-out of the main structure of the TETs-ZITT with the set of sections Pt-80 + T-110 + Pt-135 + T-175.

a - plane
b - section
1 - boiler unit BKZ-420-140
2 - axial exhaust fan DOD-31-5
3 - forced-draft primary air blower VDN-32B
4 - forced-draft secondary air blower VDN-26-Pu
5 - ash trap (bettery cyclones)
6 - hammer mill MMT/1500/2510/740M
7 - untreated doal scrubber feed unit SPU 900 x 8000
8 - untreated coal transporter (belt width, 1400 mm)
9 - untreated coal bunker
10-13 - turbine units PT/100-130/13, T-110/120-130/3, PT-135/165-130/15 and T-175/210-150
14 - feed pump PE-580-185-2
15-16 - high- and low-pressure preheaters respectively
17 - condensate pump

Figure 1 (Continued)

18 - spare exciter
19 - switching and bussing arrangement supplying the station auxiliaries
20 - central control panel
21 - group control panel
22 - open transformer inatallation
23 - $65m^3$ deaerator tank with column DSP-500M
24 & 25 - high- and low-pressure piping units
26 - BROU pressure-reducing and cooling unit
27 - main pipelines for tap and untreated water and technical steam
28 - network first elevator pump SE-5000-70
29 - vacuum deaerators DSV-800 and DSV-400
30 - ejectors to vacuum deaerators
31 - heating-up pressure reducing and cooling unit
32 - tap water preheater for heating elements (PSV-315-14-23)
33 - deaerated water heater (PSV-200-7-15)
34 - preheater boiler (PSV-315-14-23)
35 - water-water untreated water preheater
36 - blower TV-80-1.8
37 - flush water pump D-630-90
38 - irrigating water pump D-800-28
39 - freight elevator, 2 tons
40 - passenger " , 350 kg
41 - freight " , 1 ton
42 - electrical overhead crane
43 - " " "
44 - jib, 3.2 tons

a - Temporary end section
b - T-175 section
c - Doborochnaya section
d - PT-135 section
e - T-110 section
f - PT-80 section
g - Constant end section

central control panels in the addition of a machine room at the outside wall, in which are placed storage batteries, direct current panels, the blower equipment of the machine room, etc.

A technical and economic comparison of the expenditure of structural designs, cables and busses has shown that the indicated advantages permit in the final account reducing the material, technical and labor resources and also the cost in comparison with the lay-out adopted in the TETs-68 plan.

The supporting and enclosing components of the main structure, consisting of a panel-frame building, were constructed of reinforced concrete. The building framework (without additions for the group and central control panels) in transverse direction consists of a four-bay framework of various heights with a hinged support of girders of the ceilings of bays of the machine, boiler and exhaust fan departments and rigid fastenings of the bunker-deaerator section bay. The section bays have the following widths: 39 m for the machine section, 12 m for the bunker-aerator section, 42 m for the boiler section and 27 or 36 m for the exhaust fan section. The height at the level of the base of the roof panels was: 30.3 m for the machine section, 38.4 m for the bunker-aerator section, 52.9 m for the boiler section and 25.5 m for the exhaust fan section. The spacing of the framework columns in longitudinal direction is 12 m (Fig 1).

The plan provides for the possibility of applying completely molded or squared two-branched columns. The two-branched columns are made without cantilevers.

A technical and economic comparison of different alternatives of prefabricated reinforced concrete columns of the main structure is presented in Table 2.

Table 2

Indicators	Two-branched: completely molded	Two-branched: squared	Continuous (TETs-68 plan)
Expenditure of prefabricated reinforced concrete, %	100	100	210
Expenditure of steel and fittings, %	100	100	120
Total cost, %	100	126.5	160
Labor expenditures, %	100	100	110

Notes:

1. In the comparison it was assumed that all the lay-out and design solutions in both the technological and the structural parts of the plan remain unchanged. The geometric dimensions of the two-branched columns are identical in the two alternatives.

2. The increased cost of the squared structures over the completely molded results from the increase of labor expenditures on the manufacture of the structures at a plant.

3. The increase in the cost of columns in the standard TETs-68 plan is connected with increase in the expenditures of prefabricated reinforced concrete. The necessary alternative of the two-branched columns should be selected with correlation of the plan of the main TETs-ZITT with the specific conditions with consideration of the productive possibilities of the manufacturing plants in the given region.

The data presented in Table 2 show that the application of solid reinforced concrete columns used in the TETs-68 plan must be strictly limited and forbidden in the future.

The expenditure of materials on the manufacture of structures for one axis of the main structure building according to the TETs-ZITT and existing TETs plans is given in Table 3.

The specific indicators per kilowatt of installed capacity relating to the expenditure of building materials on construction of the TETs-ZITT main structure are presented in Table 4.

Table 3

TETs	Concrete expenditure, m^3	Steel expenditures, tons on fittings	on metallic structures	total
ZITT	156.5	41.7	73.1	114.8
Barbaul'skaya	285.5	85.4	81.3	166.6
Abakanskaya	-	-	280.9	280.9

Note: The expenditure of construction materials on the construction of the TETs-ZITT main structure per kilowatt of installed capacity, and also the structural volume and area of the site are presented in Table 4.

Table 4

Indicators	TETs power, MW 420*	600**	840***
Structure volume, m^3	1.76	1.69	1.54
Construction site area, m^2	0.049	0.045	0.042
Volume of reinforced concrete of above-ground part (without foundations under turbine units), m^3	0.023	0.020	0.018
Expenditure of metal structures, kg	9.94	9.19	8.94
Expenditure of fittings on above-ground part, kg	2.71	2.42	2.15
Total expenditures on steel, including fittings on underground part, kg	12.65	11.61	10.38

*Set of sections: constant end + PT-80 -110 + T-175 with group control panel + temporary end

**Set of sections: constant end + PT-80 + T-110 + PT-135 + section + T-175 + temporary end

***Set of sections: constant end + PT-80 + T-110 + T-175 + section + T-175 + T-175 + temporary end

The plan of the TETs-ZITT with the BKZ-420-140 boilers was examined by the Scientific and Technical Council of the USSR Ministry of Power and approved by the Council of the Main Administration of State Experts of the USSR Gosstroy. At the present time the working drawings are being prepared by the All-Union Scientific Research and Planning Institute of the Power Industry with consideration of the comments and suggestions of the commission of experts of the USSR Ministry of Power and the Main Administration of State Experts.

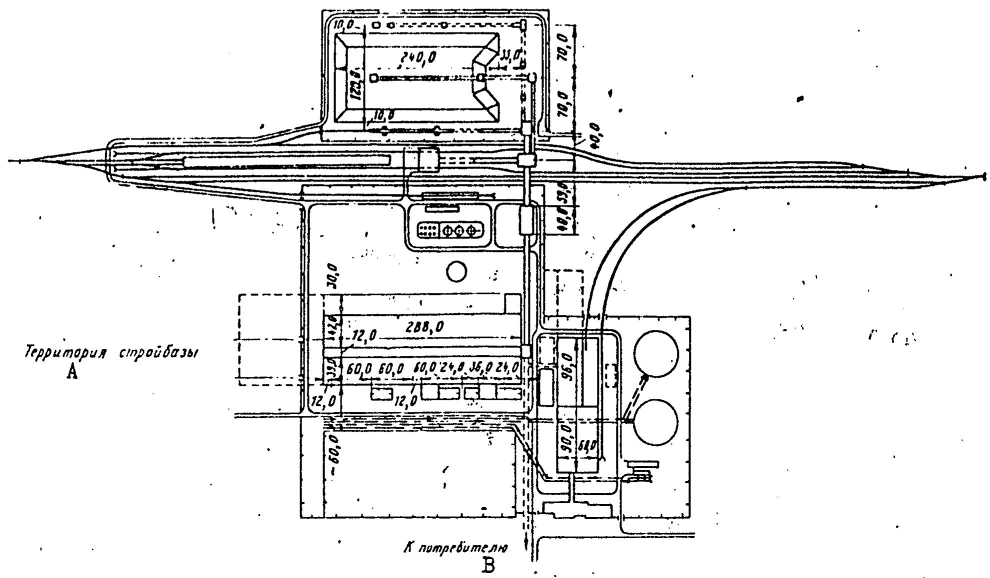


Fig 2. One alternative of the TETs-ZITT general plan.

A -- area of construction site B -- to user

The volume and planning solutions of the main building permit arranging it on the general plan in different variants as a function of the local conditions of a specific facility:

--the presence of a hot-water boiler-room;

--the type of fule adopted for the hot-water boiler-room (gas, fuel oil or solid fuel);

--the thermal conductivity of the used hot-water boilers for soild fuel;

--the degree and character of the interconnection of the auxiliary structures;

--the relief and dimensions of the area allocated for the TETs structure.

In the development of the constant end section provision was made for the possibility of interconnecting the main TETs building with a combined-auxiliary building developed by the All-Union Scientific Research and Planning Institute of the Power Industry for gas-fuel oil and coal dust TETs. At the present time, in accordance with the standard design plan of the USSR Gosstroy, working drawings are being completed for a combined-auxiliary building for coal-dust TETs, drawings in which provision has been made for two variants of the interconnection of auxiliary structures that provide different solutions of the general plan.

Modifications also are being created of the constant end section of the main building, modifications that permit if necessary interconnecting the main and auxiliary structures with the main building (of the combined-auxiliary building type).

In accordance with the coordinated plan of the State Committee for Science and Technology the All-Union Scientific Research and Planning Institute of the Power Industry has proceeded to prepare a series plan of a TETs-ZITT with boilers with a steam output of 670 tons/hr from the Taganrogskiy Boiler Plant and the Leningrad Metal Plant T-180 turbine with intermediate superheating. The lay-out decisons of that plan are being unified to a considerable degree with the solutions adopted for the TETs-ZITT with BKZ with a steam output of 420 tons/hr (Fig 2).

2174
CSO: 1822

ELECTRIC POWER

UDC 624.15.621.315.66

MANUFACTURE OF FOUNDATIONS OF VL 35-500 KV SUPPORTS WITH HEAT TREATMENT IN AN ELECTROMAGNETIC FIELD

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 3, Mar 80 pp 39-41

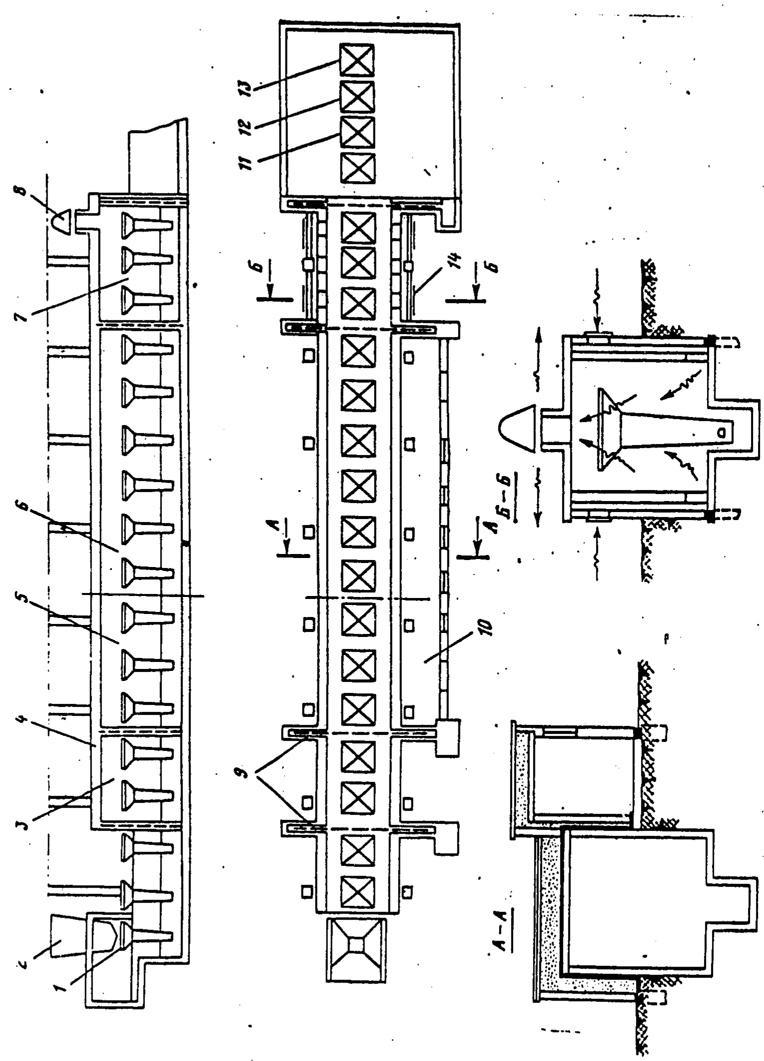
[Article by N. A. Abdulkhanov, candidate of technical sciences, and V. A. Zakuskin, engineer]

[Text] One of the most important reserves for increase of the production of reinforced-concrete articles is improvement of the process of heat treatment, which occupies 70-80 percent of the time of the entire manufacturing cycle. The most widely used heat transfer agent is steam. However, steam-curing is not an effective enough method of heat treatment of very thick articles, since when the cross-sectional height of an article increases the time required to warm it thoroughly increases considerably. Thus, when the thickness of an article doubles its heat-treatment time is 4 times as great.

In a number of cases it is advisable to heat treat reinforced-concrete articles of great thickness and with a large reinforcement coefficient in an electromagnetic field with a current of industrial frequency (in induction chambers). In that case the heat treatment of the concrete of an article proceeds more intensively than heat treatment by steam (the concrete is heated both from within by the reinforcement set in it and from outside by the steel forms, the temperature drop over the thickness of the article being insignificant--not more than 7°C).

In 1978 the introduction section of the experimental production and technical enterprise Energotekhprom jointly with the design office of the Severo-Kavkazskiy Combine of Industrial Enterprises developed and tested (on the combine's polygon) a technological conveyer line for the manufacture of VL 35-500 kV support foundations with heating in an electromagnetic field with a current of industrial frequency.

The conveyer line consists of the following basic mechanisms: a concrete pourer, a vibrator, a shaker with a drive, a control panel, a roller conveyer, an electromagnetic tunnel chamber, a mold producer, a hydraulic extruder with a control panel, a pumping station for mold lubrication and



Block diagram of an electromagnetic chamber. (Continued)

Key to Diagram on Preceding Page:

1 - containing article
2 - concrete pourer
3 - preliminary curing zone
4 - electromagnetic chamber
5 to 7 - zones of heating, isothermic curing and cooling of articles respectively
8 - roof ventilator
9 - hermetic sections
10 - corridor containing electrical equipment
11 to 13 - stations for extrusion, cleaning, lubrication and reinforcement
14 - grids with mobile louvers

a reverse conveyer with drive. In addition there are stations for the molding, holding, heating, isothermy and cooling of articles, extrusion, cleaning and lubrication, reinforcement, etc.

The mold with the included reinforcement is fed by a crane to the forming station, equipped with two vibrators arranged on the edges of an areaway into which the mold is lowered. During filling of the mold with concrete it is simultaneously compacted. After final compaction the operator at the control panel switches on the shaker, which feeds the mold containing the article to the holding station, after which the mold gradually is pushed into an electromagnetic chamber, where the article undergoes heat treatment.

The continuously operating electromagnetic chamber consists of a half-buried tunnel 45 m long with a roller conveyer to advance the molds containing the article and an inductor of bare aluminum wire.

The chamber is conventionally divided into five zones:

--for curing articles at the outside air temperature for 1 hour;

--for curing articles at the temperature in the chamber of 20°C for 1 hour;

--for heating articles to the temperature of isothermic curing for 1.5 hr;

--for isothermic curing at 80°C for 3 hours;

--for cooling of articles in 1.5 hours.

Heating zone sections have 15 coils (in two filaments) and the isothermic curing sections have 24 coils (in one filament).

Sixteen articles are simultaneously placed in the electromagnetic chamber, nine of them in an electromagnetic field. The cycle of molding of articles and advance of the metal molds along the conveyer takes 30 minutes. The capacity of the line is two articles per hour.

On the ends (in the directions of loading and unloading) the chamber is equipped with extensible hermetic sections. The article cooling zone is separated from the remaining part of the chamber by the same sections.

In the summer a KTsZ-90 roof ventilator with a 0.4-kW electric motor is used to cool articles. In the winter, articles are cooled because heat is transmitted from the molds and articles to the surrounding structures of the chamber. The outside air, before it enters the cooling zone, is preheated by the heat arriving from the surrounding structures into the air gap of the chamber enclosure. In the winter (the minimum temperature of the outside air was taken to be -17°C in the calculations) the air gap works as a thermal insulating layer in the general structure of the enclosure, for which grids are provided with mobile louvers tightly closed in the winter.

After heat treatment the mold is fed to the hydraulic extruder, on which it is fastened by clamps. The extrusion of the article in one piece is accomplished by hydraulic cylinders with a force of 1200 kN, after which the article is fed by a crane to the station for delivery and reception of the technical control section.

Then the article is set on a tilter in a position convenient for the sling, is slung and is placed on a dolly.

The released mold is transferred on the conveyer to the cleaning station, where concrete residues are removed, and then to the lubrication station, where an emulsifying lubricant is applied on its surface. The crane places the reinforcement framework in the mold and transfers it to the roller of the reverse conveyer, which feeds it to the molding station. The cycle is then repeated.

The uncovered molds developed by the design office of the Severo-Kavkazskiy Combine of Industrial Enterprises have a number of advantages over the covered, in particular, greater stiffness of the metal mold and, consequently, good quality of the surface of molded articles. In addition, as a result of the exclusion of operations on the opening and closing of the sides, durability is improved and simplicity of mold servicing is assured, and thanks to the curtailment of manual operations, the labor-intensiveness of their disassembly and assembly is reduced and, finally, operations on the removal of concrete residues from molds are simplified, since when an article advances over the mold surface no excessive concrete remains on it.

Outside the chamber a room is built in which cabinets containing condensers, electrical apparatus and control stations are installed. The control panel and instrumentation are insalled directly at the chamber entrance.

Since the inductor's power factor for heat treatment of supports is 0.3-0.35 it is considered advisable to compensate the reactive power by switching on condenser batteries between the supply transformer and the installation (in that case the cos ϕ of the installation approaches unity).

The temperature of the medium in the chamber during the heating of articles is controlled by transducers situated in the various zones. The temperature regulation in the course of the entire heat treatment process is by remote control by means of ratiometers. The "on-off" switching knobs, the signal apparatus and the magnetic starter units are on the control panel.

The technical data for the chamber are as follows:

Design productivity	15,000 m^3/year
Production area	530 m^2
Output per m^2 per year	28.3m^3
Installed capacity	440 kW
Including:	
in the heating zone	240 kW
in the isothermy zone	180 kW
Current	alternating
Frequency	50 Hz
Voltage	380/330 V
Power factor	0.95

Conveyer production of reinforced-concrete articles is a type of assembly-line production. The mold and the molded articles are moved along the production line by means of special transport devices that form a part of production lines. The combination of technological stations into a single conveyer line with an electromagnetic chamber permits sharply reducing the number of crane operations.

The annual saving from the application of induction heating of supports at the designed capacity of the concrete plant of 15,000 m^3 of concrete per year, thanks to the regulated and economic expenditure of electric power, increase of the mold turnover and reduction of their quantity amounts to about 30,000 rubles. In addition, the quality of the articles is improved, the equipment lasts longer and the general technological level of production is raised.

The strength of the concrete by the moment of cooling corresponds to 70 percent of the grade quality. The electric power consumption in that case is 85 kW x hr/m^3. Reduction of the heat-treatment time permits increasing the output of finished articles while the scales of the production areas of enterprises remain unchanged. Increase of the output per unit of production area considerably reduces the cost of produced articles.

The electromagnetic chamber is a low-temperature thermal installation, and so the calculations of enclosing structures and their heat losses to the environment were made in accordance with Construction Norms and Regulations (SNiP) II-A.7-62.

The technology for the manufacture of foundation supports on a conveyer line with heat treatment in an electromagnetic field by a current of industrial frequency at the present time is very progressive. The introduction of electromagnetic chambers at other plants of Glavenergostroyprom also is being scheduled.

2174
CSO: 1822

ELECTRIC POWER

UDC 621.316.3:621.311.4.002.2

PROGRESSIVE DESIGN OF VL 35-110 KV APPROACHES TO TYPE KTPB SUBSTATIONS

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 3, Mar 80 pp 14-15

[Article by Ye. M. Sapozhnikov, A. K. Dzharzhanov and N. G. Konstantinova]

[Text] In recent years KTPB produced by the Kuybyshev "Elektroshchit" plant (the variant without portals) have become widespread in rural electric power systems because of advantages such as complete plant readiness, the reduction of labor expenditures and construction periods and savings of metal and concrete.

However, along with that the KTPB have an important shortcoming: to provide lightning protection, metallic edge supports with rod lightning arresters, mounted in the direct vicinity of the enclosure, are needed. Those supports require large amounts of metal and large labor expenditures for installation. The foundation of each support consists of four reinforced concrete mushroom-shaped supports, for the installation of which in open basins large labor expenditures and a complex technology also are required.

In connection with that the application of single-column reinforced-concrete supports with rod lightning arresters is the most rational. However, the presence of tension members in the reinforced concrete supports does not permit bringing them maximally close to the station enclosure (provided the distance between the conductors and the enclosure is limited), As a result the lightning arresters are at a considerable distance from one another and, consequently, lightning protection of the substation is not provided.

To avoid those shortcomings when reinforced concrete supports are used on the approaches to KTPB, the authors of this article have developed designs of so-called dummy intermediate supports with rod lightning arresters that are installed between the station enclosure and the edge support that assumes the stress of the final anchoring span. Such supports must be placed at distances of 1.5-5 m from the enclosure and 12-15 m from the final support in the direction of both the 110 kV outdoor distribution system and the 25 kV outdoor distribution system (Fig 1). In that case the section of the VL (overhead line) between the final and substation supports will

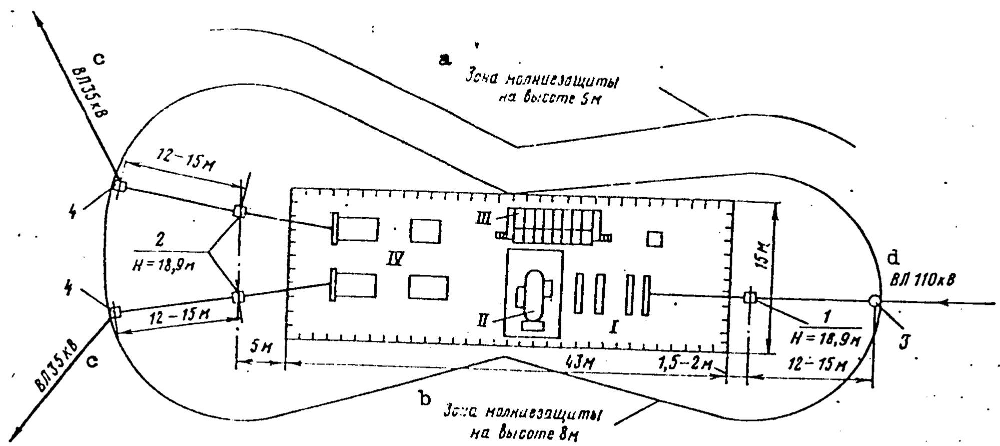


Fig 1. Overhead line approaches to a substation.

1 - 2 -- intermediate dummy supports with VL 110 and 35 kV lightning arresters (H is the lightning arrester height)
3 -- end support with VL 110 kV guy wires
4 -- anchor-angle support with VL 35 kV guy wires
I -- 110 kV outdoor distribution system
II -- power transformer
III -- 10 (6) kV distribution system
IV -- 35 kV outdoor distribution system
a -- Lightning protection zone at a height of 5 m
b -- Same at a height of 8 m
c -- 35 kV overhead line
d -- 110 kV overhead line

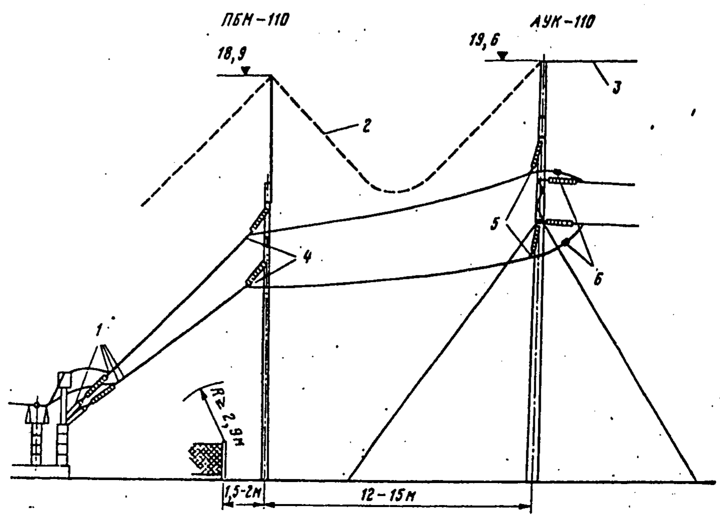


Fig 2. Approach of 110 kV overhead line to substation.

1 -- tightening device
2 -- lightning protection zone
3 -- lightning protection cable
4 & 5 -- tightening and supporting clamps
6 -- places of conductor welding

be protected against lightning overvoltages by a lightning arrester and cable and the substation equipment by lightning arresters installed on dummy supports (Fig 2).

As a result of replacement of one metal support by two reinforced-concrete single-column supports a considerable saving of metal and reinforced concrete is achieved, labor expenditures are reduced and the technological level of the VL 35 and 110 kV structure is raised.

To provide lightning protection of two-transformer KTPB substations with a voltage of 110/10 kV, which do not have a 35 kV outdoor distribution system, separately standing lightning arresters are used, installed in the direction of the 10 kV distribution system and dummy supports in the direction of the 110 kV outdoor distribution system.

The Kazakh department of Sel'energoproyekt has been using reinforced-concrete supports on KTPB approaches since 1976. The annual saving of metal (per 1oo substations) is 600 tons or more and the saving is about 115,000 rubles. The volumes of earthwork, labor expenditures and construction times are considerably reduced.

2174
CSO: 1822

FUELS

UDC 553.98:041:551.73(575.16)

OIL AND GAS PROSPECTS OF WESTERN UZBEKISTAN

Tashkent UZBEKSKIY GEOLOGICHESKIY ZHURNAL in Russian No 1, Jan 80 manuscript received 15 Apr 78 pp 61-63

[Article by V. N. Bashayev, I. A. Fuzaylov, D. A. Shaposhnikova and K. Sh. Yuldashev, Institute of Geology and Prospecting for Oil and Gas Fields of the Ministry of Geology of the Uzbek SSR]

[Text] Paleozoic rock in specific tectonic zones is represented by essentially nonmetamorphized, weakly dislocated formations and comprise a so-called intermediate structural level, widely developed within the Turanskaya series [1-3, 6]. A. M. Akramkhodzhayev [1], N. Ya. Kunin [6], M. A. Akhmedzhanov and O. M. Borisov [2], V. A. Bush and L. G. Kuryukhin [3], I. A. Fuzaylov [4], Sh. D. Davlyatov and others have repeatedly indicated the possible oil and gas content of this rock in Central Asia.

The given concepts are convincingly confirmed by the oil and gas shows of the Chu-Sarysuyskaya depression, Ustyurt, the Bukhara-Khivinskaya province and other regions. The area of development of this complex* consists of Hercynian median and boundary masses whose basement (the crystalline basement) is of ancient (Archean-Early Proterozoic?) age. The Kuramino-Fergana median and Karakumy-Tadzhik boundary masses, separated by the Yuzhno-Tyan' Shan' folded system, are distinguished from existing tectonic regionalization diagrams [2, 4] in Western Uzbekistan.

Numerous investigations have refined the contours of the large structures and the volcanic-plutonic structures with intensively developed magnetism, fractured, block and folded structures the material composition and vertical thickness of the Riphean-Paleozoic formations superimposed on them have been established. Diagrams of the material composition and a surface relief map of pre-mesozoic formations and diagrams of the surface relief of the crystalline foundation and the thickness of the Riphean-Paleozoic formations of Uzbekistan and the adjacent sections of Turkmeniya and Kazakhstan which we compiled were used to determine the areas of development of

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* M. V. Muratov called this complex a syngeosynclinal sedimentary metal of median masses.

weakly dislocated Paleozoic formations promising with respect to oil and gas content [4, 5].

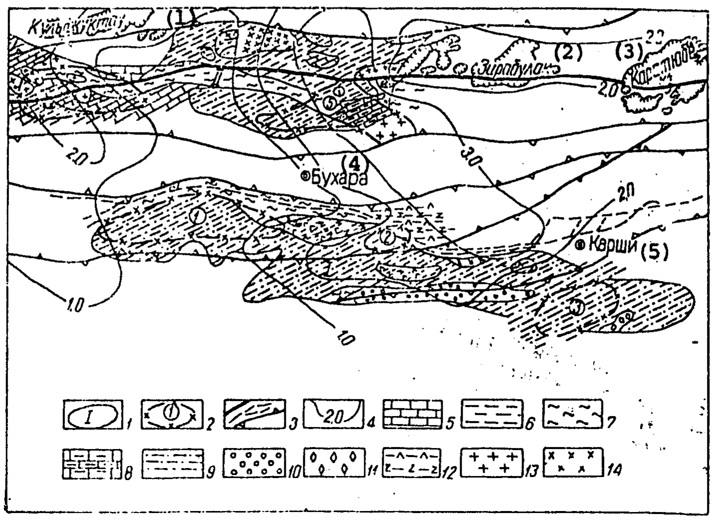
A map of the anomalous magnetic field, seismic prospecting data and mainly local field anomalies Δg obtained by recalculation of the gravity anomaly field to the upper half-space to a height of 5-10 km (with preliminary elimination of the effect of the sedimentary metal) and also of the difference field $\Delta gh = 5- \Delta gh = 10$, were used to determine the zones of reduced density within the Riphean-Paleozoic mass.

The method of studying the material composition and of compiling the enumerated maps are outlined in detail in [4]. Materials from a number of KMPV [Correlation method of refracted waves] profiles within the Southern Pre-Urals and the Chardzhou and Bukhara tectonic stages were interpreted during supplementation and refinement of the previously compiled surface map of the crystalline basement [4]. Waves with boundary velocity of 6.0-6.5 km/sec, conditionally stratified as an Archean-Early Proterozoic surface, were determined on the seismograms. The determined seismic plots supplemented available data on the depths of deposition of the crystalline basement and its morphological structures.

Sections of development of weakly dislocated pre-mesozoic sedimentary formations (areas in the Karakumy-Tadzhik boundary mass, see figure) were determined during compilation of the given materials with a diagram of material composition.

The first zone is territorially located within the Chardzhou stage and encompasses parts of the Karakul' and Beshkent troughs. Three sections of abnormally reduced density are determined in it. The first, 90 X 20 km in area, is located in the northwestern part of the Karakul' trough and is characterized by wide development of Upper Paleozoic (C_3) shales and sandstones. The thickness of the Riphean-Paleozoic (Rf-Pz) complex comprises 1-1.5 km here and the depth to the surface of pre-mesozoic formations is 3 km. Section 2 (30 X 15 km) is confined to the central part of the Chubash Chubash-Karshy flexure-fault zone (the region of the Izpanly-Chandyrskoye uplift). Paleozoic deposits are represented by shales and sandstones, the depth to the Pre-Mesozoic surface is approximately 3.5 km and the thickness of the Rf-Pz complex is approximately 2.5 km. Section 3 (50 X 20 km) is located within the Bashkent trough and consists of restratified shales and sandstones of the Upper Carbonaceous . The depth to the Pre-Mesozoic surface is 5-6 km and the thickness of the Rf-Pz surface is approximately 1 km.

The second zone is determined within the Bukhara stage and also includes a number of sections. Section 4 (70 X 35 km) occupies the transition zone from the Tuzkoyskaya trough to the Gazliyskoye uplift. The thickness of the Rf-Pz complex is approximately 1.2 km and the depth to Pre-Mesozoic rock is approximately 1.2 km. Section 5 (80 X 20 km) is located within the Rometanskiy trough and the Kaganskoye uplift and is represented in the upper part by limestones and shales of the Upper Paleozoic. The Rf-Pz



Layout of Weakly Dislocated Sedimentary Pre-Mesozoic Deposits of Western Uzbekistan:
1--regional zones of Pre-Mesozoic formations of reduced density (the figure 1--number of the zone); 2--local sections of Pre-Mesozoic sedimentary formations of reduced density (the figure I--number of the section); 3--deep and regional faults; 4--isopachs of Riphean-Paleozoic formations; lithological composition of Pre-Mesozoic formations; 5--carbonaceous rock; 6--shales; 7--metamorphic formations; 8--terrigeneous-carbonaceous rock; 9--restratification of shales and sandstones; 10--sandstones and conglomerates; 11--highly metamorphized rock; 12--sedimentary-volcanic formations; 13--granites; 14--granodiorites, diorites and quartz diorites

Key:

1. Kul'dzhuktau
2. Zirabulak
3. Karstyube
4. Bukhara
5. Karshi

thickness in the southwestern part is 2.5-3 km, the depth to Pre-Mesozoic formations is 2.0 km, the depth in the notheas tern part is 1 km and the thickness reaches 4 km.

Thus, zones of development of weakly dislocated Paleozoic formations, usually characterized by increased thickness of the Riphean-Paleozoic mass, have been determined. Paleozoic formations are represented by terrigeneous, carbonaceous and terrigeneous-carbonaceous rock and consist of fourth-order structural (folded and fault) elements; some sections are often attracted to large tectonic disturbances.

Additional geophysical investigations, including large-scale gravimetric prospecting, seismic prospecting by OG and KMPV methods and also electric prospecting observations of MTZ [Magnetotelluric sounding] are feasible for complete study of zones for purposes of detailing and refined profiling of determined sections of increased density, refinement of roof position and the thickness of Paleozoic formations and their structural elements.

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CSO: 1822

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200090022-6

FUELS

UDC 553.04.94(45+57)

ANALYSIS OF USSR COKING COAL RESOURCES AND RECOMMENDATIONS FOR THEIR INCREASE

Moscow SOVETSKAYA GEOLOGIYA in Russian No 4, Apr 80 pp 11-29

[Article by M. V. Golitsyn, All-Union Scientific Research Institute of Economics of Mineral Raw Materials and Geological Exploration] and V. F. Cherepovskiy, USSR Ministry of Geology]: "Analysis of USSR Coking Coal Resources and Main Directions of Geological Exploration"]

[Text] "Coal is the true bread of industry."
(V. I. Lenin)

The world supplies of coal surpass 90% of all the fuel resources, therefore it is difficult to overestimate its importance for the systematic development of all branches of the national economy. Back in 1920 V. I. Lenin at the First All-Russian Founding Congress of Mining and Coal Industry Workers stated that "modern industry, factories and plants are unthinkable without the coal industry."*

General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet, Comrade L. I. Brezhnev, speaking at the November (1979) Plenum of the CPSU Central Committee indicated the importance of accelerated development of coal extraction in the essential regions of the country and the need for a reduction in the percentage of oil as a fuel for power plants.

What has been said refers completely to coking coals that are responsible for a considerable part of the all-union coal extraction. Due to a number of harsh conditions necessary for the formation of coals their supplies on the earth are limited and comprise only 9% of the total geological supplies of coal (1,264 out of 14.100 billion T). At the same time coking coals will still serve for many years as the main raw material for the production of blast furnace coke, since the introduction into practice of blast furnace-free production of pig iron by direct reduction of iron from the ore cannot compete with the blast furnace process in the visible future.

*V. I. Lenin,"Poln. sobr. soch." [Complete Collected Works], Vol 40, p 292.

According to the data of M. Rumberger [3], in 1975 the world extraction of coking coal was 620 million T, 470 million T was used for coking, and 362 million T of coke was produced. By 1985 the extraction of coking coal will rise supposedly to 880 million T.

In order to evaluate the coking coal resources and indicate the paths for broadening their base in the USSR it is necessary to give the characteristics of the coal content of basins, conditions of occurrence and age of the coals, their quality and quantity. These questions have been examined by a number of researchers [1,2].

On the territory of the USSR there is coking coal in 12 basins and 10 fields of varying age (from carboniferous to Neogenic) and geotectonic position. The differences in the conditions for accumulation and transformation of the plant substance determined the formation in these basins of coals of different composition and degree of metamorphism that possess dissimilar chemical and technological properties, that in the final analysis determine the value of the mineral fuel.

The total geological supplies of coking coal in the USSR from a 1968 estimate up to a depth of 1,800 m comprise 720 billion T, of them 577 billion T are standard. The largest supplies of standard coal are concentrated in the Kuznetsk, Taymir, Donetsk, Yuzhno-Yakutsk, Karaganda and Pechora basins.

/The areas of the basins and the fields/ with coking coal are altered from the first ten square kilometers (fields Fan-Yagnob, Aldyyar) to the first thousand (Karaganda, Ulukhemskiy, Partizanskiy basins) and tens of thousands (Taymir--75, Donetsk--60, Kuznetsk--26, Yuzhno-Yakutsk--25) square kilometers.

The greatest industrial /coal-density/ (million T/km^2) is characteristic of the Irkutsk--8.7, Kuznetsk--7.9, Ulukhemskiy--5.9 and Karaganda--5.7 basins; considerably lower--Donetsk (0.5), Yuzno-Yakutsk (0.7) basins. The average coal density for the USSR as a whole is 2.1 million T/km^2, which is considerably lower than the coal density of the basins with fuel coal.

/The total number of beds/ of coking coal in the main beds numbers many dozens and even the first hundreds (Donetsk basin). The number of working beds in the Donetsk and Kuznetsk basins reaches 50-60, Karaganda--30, and Pechora and Yuzhno-Yakutsk--20.

/The thicknesses of the beds/ of coking coal are subject to considerable fluctuations--from tens of centimeters to tens of meters (table 1). Over 75% of the coal supplies are contained in the thin (up to 1.3 m) and medium (1.3-3.5) thick beds; 20% in the thick (3.5-10 m) and 3% in the superthick (over 10 m). The thickest beds are located in Yuzhno-Yakutsk, Irkutsk (up to 50 m) and Kuznetsk (up to 20 m) basins. Beds of increased thickness (over 3.5 m) are also prevalent in the Tungusskiy, Ulukhemskiy

Table 1. Distribution of Coking Coal Supplies of the USSR According to Beds of Varying Thickness

Basin, field	Standard supplies of coal, bill. T	Supplies for beds of varying thickness, %			
		from limit of conditions to 1.3 m	1.3-3.5 m	3.5-10 m	over 10 m
USSR	577	28	48	21	3
Including:					
Kuznetsk	206,00	20	44	30	6
Taymir	163,00	25	60	15	—
Tungusskiy (Noril'sk rayon)	41,70	20	50	30	—
Lensk	37,71	40	60	—	—
Donetsk	28,00	88	12	—	—
Zyryanka	23,10	20	60	20	—
Yuzhno-Yakutsk	18,60	50	40	5	5
Irkutsk	17,30	40	30	20	10
Ulukhemskiy	11,90	33	25	42	—
Karaganda	11,35	18	42	40	—
Pechora	9,60	30	60	10	—
Uzgen	1,73	70	30	—	—
Sayano-Partizanskiy	1,58	80	20	—	—
Fan-Yagnob	1,17	20	50	30	—
Zav'yalovskiy	0,85	55	45	—	—
Samarskiy	0,77	50	50	—	—
Sakhalin Island	0,59	50	50	—	—
Kizel	0,50	60	40	—	—
Apsatskiy	0,36	10	50	40	—
Partizanskiy	0,30	30	50	20	—
Fields of the Caucasus	0,26	30	60	10	—
Aldyyarskiy	0,21	—	50	50	—

and Karaganda basins. In Donbass almost 90% of the coal supplies occur in thin beds with thickness up to 1.3 m. More than half of the supplies of the Taymir, Lensk, Pechora and Zyryanka basins and the fields of the Caucasus are concentrated in beds of medium thickness (1.3-3.5 m).

As compared to the beds of fuel coal whose thickness reaches hundreds of meters, the coking coal beds are considerably thinner.

/The degree of study/ of the main basins and fields with coking coal is fairly high. The supplies of categories $A+B+C_1$ in the Donetsk basin are 71%, Pechora 41%, Karaganda 39%, and Kuznetsk 16%. However, of the total standard supplies (577 billion T) supplies in the categories $A+B+C_1$ comprise only 12%, category C_2--5%, prediction I groups 21% and II groups 62%. This indicates the insufficient degree of study of the basins located in the eastern regions of the country where there are outlooks for the growth in explored supplies of coking coal. The overwhelming quantity of supplies can be stripped only by the underground method; only an insignificant part of the supplies in Yuzhno-Yakutsk, Kuznetsk and Irkutsk basins is suitable for open stripping.

Table 2. Distribution of Supplies (in %) of USSR Coking Coal according to Depth of Occurrence, Age and Geotectonic Types of Basins

Basin, field	Depth of occurrence, m				Age					Geotectonic type		
	0-300	300-600	600-1200	1200-1800	Carboniferous	Permian	Jurassic	Cretaceous	Paleogenic and Neogenic	Platform	Intermediate	Geosynclinal
USSR	29 (50)	29 (30)	24 (17)	18 (3)	10.9	69	10	9	0.1	15.9	84	0.1
Including:												
Kuznetsk	18 (59)	22 (32)	37 (8)	23 (1)	10	90	—	—	—	—	100	—
Taymir	46 (100)	54	—	—	—	100	—	—	—	—	100	—
Tungusskiy (Norilsk rayon)	7 (100)	4	51	38	—	100	—	—	—	100	—	—
Lensk	16	16	20	48	—	—	20	80	—	—	100	—
Donetsk	14 (20)	22 (30)	38 (41)	26 (9)	100	—	—	—	—	—	100	—
Zyryanka	21 (100)	17	28	34	—	—	—	100	—	—	100	—
Yuzhno-Yakutsk	72 (98)	13.6 (2)	14	0.4	—	—	100	—	—	100	—	—
Irkutsk	94 (100)	6	—	—	—	—	100	—	—	100	—	—
Ulukhemskiy	24 (93)	34 (7)	29	13	—	—	100	—	—	100	—	—
Karaganda	20 (43)	20 (43)	45 (12)	15 (2)	100	—	—	—	—	—	100	—
Pechora	21 (30)	41 (47)	30 (23)	8	—	100	—	—	—	—	100	—
Uzgen	20 (29)	47 (43)	29 (28)	4	—	—	100	—	—	—	100	—
Sayano-Partizanskiy	87 (92)	13 (8)	—	—	—	—	100	—	—	100	—	—
Fan-Yagnob	55 (89)	14 (7)	20 (4)	11	—	—	100	—	—	—	100	—
Za'yavlovskoye	5 (38)	33 (37)	33 (25)	29	100	—	—	—	—	—	100	—
Samarskiy	18 (48)	18 (48)	32 (4)	32	100	—	—	—	—	—	100	—
Sakhalin Island	51 (80)	25 (20)	18	6	—	—	—	10	90	—	70	30
Kizel	42 (48)	22 (26)	36 (26)	—	100	—	—	—	—	—	100	—
Apsatskiy	67	33	—	—	—	—	100	—	—	100	—	—
Partizanskiy	26 (53)	55 (19)	16 (27)	3 (1)	—	—	—	100	—	—	—	100
Fields of the Caucasus	100 (100)	—	—	—	—	—	100	—	—	—	—	100
Aldyyarskiy	5	10	33	52	—	—	100	—	—	—	100	—

Numbers in parentheses are supplies in categories $A+B+C_1$.

Standard supplies of coking coal are mainly located up to depth 600 m (58%); of them half are up to depth 300 m (table 2). Among the explored supplies in categories $A+B+C_1$ 80% occur up to depth 600 m, of them 50% up to depth 300 m. Twenty-four percent of the supplies (17% explored) are concentrated in the interval 600-1200 m, and 18% (3% explored) in the interval 1200-1800 m. All the supplies of the Taymir and Irkutsk basins, the Caucasus, Sayno-Partizanskiy and Apsatskiy fields, the majority of supplies of Yuzhno-Yakutsk, 86% (100% explored), 81% of the Partizanskiy (72%), 67% of the Uzgen (72%), 62% of the Pechora (77%) basins and 76% of Sakhalin Island (100%) are located at depths up to 600 m. In the Tungusskiy basin the main supplies of coking coal are confined to depths over 600 m (89%); only 11% are concentrated up to depth 600 m.

/The degree of development of the basins and fields/ of coking coal is not the same; of the 22 basins and fields only 6 are being used. The greatest extraction occurs at the Donetsk (87 million T), Kuznetsk (60 million T), Karaganda (19 million T), Pechora (17 million T) and Kizel (2.1 million T) basins and fields of the Caucasus (1.6 million T). Use of the Yuzhno-Yakutsk basin has begun; here at the Neryungrinskiy field coking coal extraction in future years will exceed 10 million T. Many coking coal fields have not yet been developed. This refers to the Irkutsk basin, due to the high sulfur content of the coking coal, Ulukhemskiy, due to the distance of it from the consumer, and to the fields of Central Asia where there is no iron ore base in the locality. Many basins of Siberia have almost not yet been developed by industry; this concerns the Tungusskiy, Lensk, Zyryanka, Taymir and other basins. The Taymir, especially its eastern section (Chernoyarskiy field) is the most promising of them.

Analysis of the distribution of coking coal supplies according to /age/ (see table 2) demonstrates that the main coal formation is confined to the Permian (69% of the supplies), the formation of these coals occurred in roughly equal volumes in the carboniferous, Jurassic and Cretaceous time (9-10% each) and on a very limited scale in the Paleogenic and Neogenic (0.1%). Coals of the Donetsk, Karaganda and Kizel basins are associated with the carbonaceous period, the Pechora, Kuznetsk, Taymir and Tungusskiy with the Permian, the Yuzhno-Yakutsk, Irkutsk, Ulukhemskiy and Uzgen with the Jurassic, the greater part of the Lensk, Zyryanka and Partizanskiy basins with the Cretaceous, and the coals of Sakhalin with the Paleogenic and Neogenic. On the whole a natural rejuvenation in age occurs in the coal-bearing formations in a direction from the west to the east from the carbonaceous in the Donetsk basin, the Permian in the Kuznetsk and Tungusskiy, Mesozoic in the Lensk and Yuzhno-Yakutsk basins to the Cenozoic on Sakhalin.

The USSR coking coal was formed in different /geotectonic conditions/ (see table 2). Almost all of the supplies (84%) are concentrated in basins and fields confined to varying types of depressions (foredeep, edge, intermontane, and others) that are located on the boundary of platform and folded regions, i. e., under conditions changing from geosynclinal to platform

(Donetsk, Kuznetsk, Karaganda, Pechora, Taymir basins, and a number of fields in Central Asia). The coal of the Tungusskiy, Irkutsk, Ulukhemskiy and Yuzhno-Yakutsk basins was formed under platform conditions; 15.9% of all the supplies of coking coal are concentrated here. Only the coal of Sakhalin Island, the Partizanskiy basin and the Tkibuli field in the Caucasus was formed under strictly geosynclinal conditions; they hold only 0.1% of the supplies.

It is known that the /quality of the coking coal/ is determined by its substance composition and degree of metamorphism. Coking coals in the USSR, as a rule, are humus; the sapropelite and liptobioliths that form the sparse, usually thin intercalations in the beds of humus coal are of subordinate importance. The humus coal contains four main coal-forming components in different ratios: vitrinite, semivitrinite, fusinite and leiptinite (table 3).

The most ancient lower carbonaceous coal of the Donetsk, L'vovsko-Volynskiy and Kizel basins are distinguished by an increased content of spores (up to 20-30%, and the quantity of vitrinite in them rarely exceeds 60%. In the Kuznetsk basin the coal is almost entirely made up of vitrinite. The middle carbonaceous coal of the Westphalian floristic province (Donetsk basin) is characterized by a high vitrinite content (80-90%) with a low fusinite content (up to 10%), while in the Tungusskiy floristic province (Kuznetsk basin) it is characterized by a reduced content of vitrinite (rarely more than 50%) and high fusinite (over 30-40%).

The lower Permian coal of the Kuznetsk and Tungusskiy basins usually contains little vitrinite (up to 50%) and a lot of fusinite (over 40%). In the Pechora basin the coal of this age, on the contrary, is rich in vitrinite. The upper Permian coal in the Kuznetsk and Tungusskiy basins is almost entirely made up of vitrinite (over 80%), there is usually up to 10% fusinite and 2-3% leiptinite. In the Jurassic coal of practically all basins, Yuzhno-Yakutsk, Ulukhemskiy, Irkutsk and Uzgen, there is a lot of vitrinite (80-90%), while the quantity of fusinite and leiptinite does not exceed 5%. The Cretaceous coal of the Zyryanka basin and the Neogenic coal of Sakhalin have a close composition.

It is important to note that in different geological epochs coal of the same or close group composition was formed from various plants. Thus, the vitrinite-rich coal with insignificant content of fusinite and leiptinite was formed in the middle carbonaceous period (Donetsk basin), late Permain (Kuznetsk basin), in the Jurassic (Yuzhno-Yakutsk and Irkutsk basins) and Neogenic (Sakhalin Island). At the same time the evolution of the plant world was reflected to a certain extent in the composition of the coal. For example, the coal formed in the early carbonaceous period is primarily rich in leiptinite. Apparently the main factor determining the substance composition of the coal was the conditions for conversion of the plant material, and the composition of the coal-forming plants played a smaller role.

Table 3. Quantitative-Petrographic Composition of Coking Coals of the Main USSR Basins (in % of pure coal)

Basin, field	Vitrinite	Semi-vitrinite	Fusinite	Leiptinite	Sum of meltable components	Sum of lean components
Donetsk						
Lower carbonaceous	52	3	22	23	76	24
Middle carbonaceous	85	1	9	5	90	10
Kuznetsk						
Lower carbonaceous, Ostrog series	93	1	6	0	93	7
Middle-upper carbonaceous, lower-balakhonskiy subseries	58	8	33	1	61	39
Lower Permain, upper-balakhonskiy subseries	50	8	41	1	53	47
Upper Permian						
Il'inskiy subseries	85	3	10	2	88	12
Yerunakovskiy subseries	78	4	15	3	82	18
Karaganda						
Lower carbonaceous, Karaganda series	55	11	30	3	62	38
Middle carbonaceous, Dolina series	71	5	15	9	82	18
Pechora						
Lower Permian						
Rudnitsa subseries	74	8	16	2	79	21
Inta series	72	8	18	2	77	23
Upper Permian, Pechora series	73	6	20	1	76	24
Kizel						
Lower carbonaceous	44	10	18	28	75	25
Tungusskiy (Noril'sk rayon)						
Permian	52	3	45	Fract.%	53	47
Zav'yalovskiy						
Lower carbonaceous, Karaganda series	65	5	26	4	71	29
Middle carbonaceous, Dolina series	81	5	9	5	87	13
Samarskiy						
Lower carbonaceous, Karaganda series	75	5	11	9	86	14
Middle carbonaceous, Dolina series	72	7	10	11	85	15
Uzgen						
Lower Jurassic						
Kargasha*	79	2	11	8	88	12
Tuyuk*	83	3	14	—	84	16
Fan-Yagnob						
Lower Jurassic	55	2	39	4	60	40

[Table continued on next page]

Aldyyarskiy Lower Jurassic	80	5	10	5	86	14
Irkutsk Novometelkinskiy field lower Jurassic	85	—	10	5	90	10
Yuzhno-Yakutsk Upper Jurassic	92	1	7	0	92	8
Sayano-Partizanskiy Middle Jurassic	87	2	2	9	96	4
Ulukhemskiy* Middle Jurassic						
Zyryanka Lower Cretaceous	80	—	17	3	83	17
Sakhalin Island (Uglegorskiy rayon), Neogenic	79 98	8 0	12 1	1 1	83 99	17 1
L'vov-Volinskiy Lower carbonaceous	72	2	17	9	81	19

*Approximate data.

Analysis demonstrates that the coking coal of the Lensk, Yuzhno-Yakutsk and Donetsk basins is the richest in vitrinite (over 80%) (table 4). On the contrary, a considerable part of the coal of the Kuznetsk, Karaganda, Tungusskiy and Kizel basins contain less vitrinite (usually lower than 60%) and more fusinite, which reduces its caking capacity.

Many of the important properties of coking coal developed under the influence of /regional metamorphism/ associated with its depth of submersion in the region of certain temperatures and pressures. Coal characterized by a certain stage of metamorphism occupies zones of certain thickness in the open pits of the main USSR coal basins. For example, the thickness of the zone of gas coal is 1000-1500 m, of most valuable metabituminous, coke and inert caking coals only 400-600 m each. The poor coals and anthracites cover zones whose thickness is measured in hundreds of meters and even kilometers. This explains the limited dispersion of the coking coals of brands Zh, K and OS.

The effect of thermal metamorphism due to the additional warming up of the coal-bearing layers by the heat of the magmatic bodies introduced into them was superimposed on the general background of regional metamorphism in a number of basins, especially in the Tungusskiy. Contact metamorphism was locally manifest directly on the contact of the coal and the magmatic bodies. Regionally metamorphized vitrinite-rich coal of the middle stages of metamorphism --II (G), III (Zh), IV (K) and V (OS) possess the capacity for agglomeration, however, during thermal metamorphism this important feature is not manifest. The relative short-term effect of fairly high temperatures during thermal metamorphism induces a drastic exacerbation in the tendency to cake of the coals of the medium stages and their value as a raw material for coking is reduced.

The best tendency to cake (thickness of the plastic layer y>20 mm) is found in the middle carbonaceous coal of the Donetsk and Karaganda, lower Permian of the Pechora, upper Permian of the Kuznetsk, Jurassic of the Yuzhno-Yakutsk and Irkutsk, Cretaceous of the Zyryanka basins, and the Neogenic Sakhalin coal. The coal of the lower carbonaceous period of the Karaganda, lower Permian of the Kuznetsk and Tungusskiy basins is characterized by reduced tendency to cake (y=6-15 mm).

The diversity in the substance composition and degree of metamorphism determined the different/type composition of the coal/ (see table 4). Of the total number of standard coals 22% are gas (including 5% gas metabituminous), 27% metabituminous, 30% coke (K, K_2, KZh), and inert caking (OS) --16%.

The gas coals (G) of the I-II and III stages of metamorphism, GOST 21489-76, are characterized by 33-42% yield of volatile substances and thickness of the plastic layer 6-25 mm. They are very widespread in the Donetsk (58% of the supplies), Kuznetsk (41%) and Irkutsk (100%) basins, and at the fields of the Caucasus and Central Asia. The coal of the Donetsk and Kuznetsk basins that cakes well is used in the coking burden in a quantity up to 35%. The poorly caking gas coal is used for power engineering purposes. The gas metabituminous coal (GZh) that possesses increased tendency to cake is dispersed in the Kuznetsk (13% of the supplies), Kizel (100%) and Uzgen (39%) basins.

The metabituminous coal (Zh) belongs to the III stage of metamorphism, possesses the best tendency to cake (y up to 40 mm) and has yield of volatile substances of 27-37%. They are the most developed in the Partizanskiy (100% of the supplies), Ulukhemskiy (77%), Pechora (75%), Zyryanka (30%), Kuznetsk (22%) and Donetsk (20%) basins. This coal is widely used for coking as the oily base for the burden.

Coke metabituminous (KZh) coal includes coal of the III-IV stages of metamorphism, with yield of volatile substances 22-33%, and thickness of the plastic layer 16-25 mm. It has limited dispersion (less than 20% of the supplies) in the Kuznetsk, Karaganda, Yuzhno-Yakutsk and Zyryanka basins. Coal of KZh type is widely used for coke production.

Coke coal (K, K_2) includes the caking coal with yield of volatile substances 17-33% and thickness of the plastic layer 6-25 mm. It is dispersed in the Yuzhno-Yakutsk (35% of the supplies), Zyryanka (28%), Karaganda (23%) Kuznetsk (13%) and Donetsk (11%) basins. Depending on the petrographic composition and the thickness of the plastic layer types K (y=10-25 mm) and K_2 (y=6-11 mm) are isolated. K-type coal is the scarcest.

The inert caking coals (OS) are at the V stage of metamorphism and are characterized by yield of volatile substances 14-27%, thickness of the plastic layer 6-13 mm. These are the scarcest coals after K-type coal and are completely utilized for coking as the inert additive in the burden with

Table 4. Distribution of Supplies of Coking Coal in the USSR According to Content of Vitrinite and Types, %

Basin, field	Vitrinite content, %			Types of coal					
	40–60	60–80	80–100	G	GZh	Zh	KZh	K,K_2	OS
USSR	33	36	31	22	5	27	3	27	16
Including:									
Kuznetsk	50	30	20	41	13	22	3	14	7
Taymir	20	50	30	—	—	33	—	33	34
Tungusskiy (Noril'sk rayon)	100	—	—	—	—	—	—	100	—
Lensk	—	—	100	—	1	72	—	22	5
Donetsk	5	15	80	58	—	20	—	11	11
Zyryanka	—	70	30	—	—	30	17	28	25
Yuzhno-Yakutsk	—	—	100	—	—	18	18	35	29
Irkutsk	—	100	—	100	—	—	—	—	—
Ulukhemskiy	—	100	—	23	—	77	—	—	—
Karaganda	70	30	—	—	2	2	14	23	59
Pechora	—	90	10	—	—	75	—	14	11
Uzgen	—	60	40	11	39	—	39	—	11
Sayano-Partizanskiy	—	—	100	100	—	—	—	—	—
Fan-Yagnob	—	80	20	100	—	—	—	—	—
Zav'yalovskiy	—	100	—	—	—	50	25	25	—
Samarskiy	—	100	—	—	64	12	12	12	—
Sakhalin Island	—	—	100	50	—	33	—	17	—
Kizel	100	—	—	—	100	—	—	—	—
Apsatskiy	—	100	—	—	—	—	—	100	—
Partizanskiy	—	100	—	—	—	100	—	—	—
Fields of the Caucasus	—	70	30	100	—	—	—	—	—
Aldyyarskiy	—	100	—	100	—	—	—	—	—

metabituminous coals. They are widespread in the Karaganda (59% of the supplies), Kuznetsk (7%), Donetsk (11%) and Pechora (11%) basins; often they occur at deep levels (Karaganda basin, Anzherskiy and Kemerovo rayons of the Kuznetsk basin, Khal'mer-Yu rayon of the Pechora basin).

The lean (T) coal that does not cake and is rich in vitrinite is used in the Donetsk basin as a component of the coking burden (up to 5%). Positive results have been obtained also with coking lean coal at the Pechora basin.

/According to the ash content/ in the majority of basins the coking coals belong to the average-ash (A^c 10-20%); this refers to 76% of all the supplies (table 5). The low-ash coal (A^c up to 10%) is dispersed less widely (21% of the supplies), mainly in the Yuzhno-Yakutsk, Irkutsk, and apparently also in the little-studied Taymir and Lensk basins. Almost all the coal of the Donetsk, Kuznetsk and Pechora basins is medium-ash; many beds contain less than 15% ash. The majority of coals in the Karaganda Kizel basins and a number of smaller fields are high-ash (A^c 20-30%); they account for only 3% of the total supplies. The caking coals with ash content over 30% usually belong to the group of fuel coals. Their supplies number many billions of tons, especially in the Karaganda and Pechora basins. The /tendency for enrichment/ of the coals usually correlates well with the ash content. Low-ash coal is easily enriched (yield of concentrate with density less than 1.4 g/cm^3 is generally higher than 90%); the medium-ash possess average or difficult tendency for enrichment (yield of concentrate is 70-90%, its ash content is up to 10%), the high-ash are characterized by difficult and extremely difficult tendency for enrichment (yield of concentrate is 50-70%, ash content often exceeds 10%). The coals of the Donetsk, Kuznetsk, Yuzhno-Yakutsk and partly the Pechora basins are easily and average enriched, the Karaganda --average and difficult to enrich.

In /content of total sulfur/ the majority of coking coals in the USSR (92%) belong to the low-sulfur group (up to 1.5%), whereupon 78% of the supplies are accounted for by the coal containing up to 0.5% sulfur (see table 5). The coal of the Kuznetsk, Zyryanka, Yuzhno-Yakutsk, Karaganda, Ulu-khemskiy, Pechora, Uzgen, Partizanskiy basins is distinguished by low sulfur content (up to 1.5%). Coal of the Donetsk (60% of the supplies), Irkutsk (90% of the supplies), Kizel (100% of the supplies) basins and the Zav'yalovskiy field in Kazakhstan contains over 2.5% sulfur. There is an especially high sulfur content in the coal of the Irkutsk and Kizel basins (usually over 4%). In the coals of the main basins, Donetsk, Kuznetsk, Pechora, Karaganda, the sulfur is primarily pyritic, while in the Irkutsk and Kizel basins--organic. The sulfate sulfur in the coking coal in the majority of basins is up to 0.5%. One should note the drop in the quantity of sulfur in the coking coal with the rise in its degree of metamorphism (Donetsk and Karaganda basins) and the increase in the content of fusainized components.

The /phosphorous content/ (see table 5) in the coking coal is very diverse. One-fourth of the supplies of coal belong to the low-phosphorous (up to 0.01%), 60% to the medium-phosphorous (0.01-0.05%) and 15% to the high-phosphorous (over 0.05%). The coal of the Kuznetsk basin contains the greatest amount of phosphorous--sometimes over 0.1%. The coal of the Zyryanka, Taymir, Karaganda (upper coal-bearing series) basins and Sakhalin are characterized by an increased phosphorous content. However, the coal in the majority of basins (Donetsk, Pechora, Yuzhno-Yakutsk, Irkutsk, Kizel, and others) belong to the low- and average-phosphorous. No clear relationship has been established between the content of phosphorous and genetic conditions. In the Karaganda basin the phosphorous content of the coal is usually proportional to their content of vitrinite. Phosphorous is more often linked to the organic part of the coal, which is indicated, in particular, by the absence of a link between its content and the ash content. Therefore, in the process of enrichment the phosphorous content is usually reduced insignificantly.

The main suppliers of coking coal in the USSR are the Donetsk, Kuznetsk, Karaganda and Pechora basins, and the Kizel basin and fields of the Caucasus to a lower degree.

The average indices for the quality of the enriched coals for coking are as follows: A^c7.5-11.1%; S^c_{o6} 0.6-2%; V^r 25-30%. The strength of the coke according to the M 40 index is 75-80%, M 10--6.7-9.4%.

Table 5. Distribution of Supplies (in %) of Coking Coal in the USSR according to Content of Ash and Sulfur

Basin, field	Ash content (A^c) %			Sulfur (S^c_o), %					Phosphorus (P^c), %			
	up to 10	10–20	20–30	up to 0,5	0,6–1,5	1,6–2,5	2,6–4,0	over	0,01	0,01–0,05	0,06–0,1	over 0,1
USSR	21	76	3	78	14	2	3	3	25	60	13	2
including:												
Kuznetsk	—	100	—	100	—	—	—	—	30	50	15	5
Taymir	50	50	—	80	20	—	—	—	30	50	20	—
Tungusskiy (Noril'sk rayon)	10	80	10	50	40	10	—	—	—	100	—	—
Lensk	50	50	—	100	—	—	—	—	—	100	—	—
Donetsk	10	90	—	—	20	20	50	10	10	85	5	—
Zyryanka	—	100	—	100	—	—	—	—	20	50	30	—
Yuzhno-Yakutsk	50	50	—	90	10	—	—	—	80	20	—	—
Irkutsk	30	70	—	—	5	5	10	80	—	100	—	—
Ulukhemskiy	—	100	—	90	10	—	—	—	40	60	—	—
Karaganda	—	20	80	10	78	10	2	—	10	70	20	—
Pechora	—	90	10	—	100	—	—	—	20	70	10	—
Uzgen	20	80	—	—	100	—	—	—	100	—	—	—
Sayano-Partizanskiy	—	100	—	—	100	—	—	—	—	100	—	—
Fan-Yagnob	—	100	—	—	—	100	—	—	—	100	—	—
Zav'yalovskiy	—	—	100	—	—	30	60	10	—	30	70	—
Samarskiy	—	10	90	—	—	90	10	—	—	30	70	—
Sakhalin Island	—	100	—	100	—	—	—	—	—	40	60	—
Kizel	—	—	100	—	—	—	—	100	—	100	—	—
Apsatskiy	—	100	—	—	100	—	—	—	—	100	—	—
Partizanskiy	—	100	—	50	50	—	—	—	—	100	—	—
Fields of the Caucasus	—	—	100	—	20	80	—	—	—	100	—	—
Aldyyarskiy	—	100	—	—	—	100	—	—	—	100	—	—

What are the paths towards increasing the resources of coking coal? It is known that to obtain high quality metallurgical coke coking coal of certain types is required, and this obliges the geologists to explore for coals of a strictly determined quality. Underestimation of this conclusion resulted in the fact that the type composition of the coals of many explored sections does not always meet the type composition of the coals used in coking (table 6).

Whereas at the active enterprises the fraction of coals of different types in the supplies and the coke burden is close, at the enterprises under construction, the reserve and long-term exploration sections the fraction of gas coals is great; it reaches 36-55% (in the burden 24%), while that of coke coals is reduced to 13-21% (27% in the burden). There is an available surplus of explored supplies of gas coal (in the first place in the Donetsk and Kuznetsk basins) and a shortage in the coking, types Zh, K and OS. It is known that the gas coal can be successfully used to obtain molded coke, however in the next five-year periods the scales of industrial production of this type of coke will be very limited for a number of reasons. Therefore the chief raw material for production of blast furnace coke remains coal of types Zh, K and OS.

Such a situation with coking coal is due to a number of circumstances. First of all, in the main basins supplying industry with coking coal, Donetsk and Kuznetsk, more than half of the supplies are gas coals. Secondly, in the not too distant past great hopes were placed on the most rapid introduction into practical production of molded coke made of gas coal, which would permit a sharp increase in the use of this coal in the coke production. The industrial mastery of this method is being delayed, and in the visible future a considerable portion of the explored and extracted gas coals will not be able to be used for coking. Thirdly, the areas for spread of gas coals are distinguished by simple structure, and therefore are conveninet for development, while the sections with Zh, K and OS types of coal lie at great depths or in tectonically-complicated regions.

We will dwell on an evaluation of the outlook for the main coal basins of the USSR and substantiation for the main trends in the geological and exploratory work on coking coal, i.e., we will examine the ways to increase its resources.

More than half of all the coking coal in our country is extracted in the Donetsk basin. Their standard supplies up to depth 1,800 m are evaluated at 28 billion T, of them the balance supplies are 19.5 billion T. The output of the explored reserve of coking coal at the beginning of 1979 was 24.3 million T per year, including 11.2 million T for coal types GZh, Zh, K and OS. However, practically all the reserve sections are located at great depths and under complicated mining-geological conditions.

Analysis of the structure of the supplies indicates that in the basin the gas coal has been explored too much (its fraction in the supplies is 67%,

Table 6. Distribution of Supplies (in %) of Coking Coal and Burden according to the Composition in the Main Basins of the USSR (according to the condition as of 1 January 1979)

Basin	Supplies, cat. $A+B+C_1$ bill. T	Type composition of supplies (coke burden in parentheses),%			
		G+GZh	Zh+KZh	K	$OS+T_{kokc}$
USSR	68,0	47 (24)	26 (37)	18 (27)	9 (12)
Including for the basins:					
Donetsk	19,5	67 (34)	13 (33)	8 (16)	12 (17)
Kuznetsk	32,2	46 (17)	25 (26)	23 (49)	6 (8)
Karaganda	4,7	3	28 (64)	39 (34)	30 (2)
Pechora	3,6	6	84 (84)	4 (16)	6
For groups of development:					
Active enterprises	14,7	31	31	28	10
Enterprises under construction	2,0	55	23	21	1
Reserve of subgroups, "a" and "b"	6,4	36	38	14	12
Explored sections	8,9	50	30	16	4
Sections for future exploration	18,9	53	26	13	8
Other sections	17,1	57	15	16	10

and in the coke burden only 34%) and the coal of sorts Zh, K and OS not enough (fraction in the supplies 33%, in the burden 66%). In recent years the fraction of gas coal in the burden has risen from 29% in 1965 to 34% in 1975. However, a further increase in the participation of gas coal in the burden is being held back due to the shortage of coal of types K and OS, as well as the weak development of work on the industrial production of formed coke.

It should be noted that the main supplies of the scarcest coals of types Zh, K and OS that are concentrated in the central, Donetsk-Makeyevka and Almazno-Mar'yevka regions, have already been depleted to a considerable degree, and the sections that are promising for exploration are usually small in area and supplies. Therefore, in addition to exploration of these sections, a reevaluation is needed of the outlook for certain regions with scarce type coals that were previously rejected for some reason. One of them is the Tatsino region in eastern Donbass, where a number of fields with high quality coal of types Zh, K and OS and supplies of several hundreds of millions of tons, but with fairly complicated mining and geological conditions were explored in its time. Now, when all the simple mining fields for stripping coal at shallow depths have already been developed, one should reevaluate the potentialities of this region. It is also necessary to resume the searches for coals of types Zh, K and OS at other promising areas of eastern Donbass, without being restricted to searches for sections only with the traditional anthracites here. The intensification of work on coals of types K and OS in the Donbass must be accompanied by a reduction in the volumes of explorations of the gas coals. The vitrinite-rich, usually low-sulfur lean coal whose participation in the burden at individual plants reaches 4-5% can serve as a definite reserve for increasing coal resources for coking. This, in addition, will permit a reduction in the total sulfur content of the burden. The coals contained in the thin beds (0.40-0.55 m) that are currrently classified with the group of balance represent a considerable reserve in the Donbass. The supplies of these coals reach 6 billion T, including up to depth 3000 m--1.5 billion T.

The Kuznetsk basin has the largest supplies of standard coking coal in the USSR (206 billion T, balance 32.2 billion T). About one-third of the coal for coking is extracted here.

In the beginning of 1979 the output of the reserve fund was 17.4 million T per year; of this coal types Zh, K and OS comprised 6.2 million T. An important feature of the Kuznetsk coal, in addition to the low ash content and good enrichability, is its low sulfur content. The explored supplies of coking coal in the basin guarantees in a quantitative respect the planned development of the coal industry. As for the qualitative composition of the coal, then here, as in the Donbass, the noncorrespondence between the explored supplies of coal of certain types and their demand by the by-product coke industry is known. Almost 46% of the explored coal supplies are gas and only 26% are coke, while three times less gas coal is used for coking than coke coal.

In the last 15 years the percentage of gas coal in the supplies of the Kuznetsk basin has risen almost 1.5-fold--from 34% in 1960 to 46% in 1975, while the percentage of metabituminous and coke coal was respectively reduced from 27 to 22% and from 31 to 26% with stability in the composition of the coke burden (type G 17%, Zh 26%, K 49%). The extraction of gas caking coals considerably surpasses the coke industry's demand for them, as a result of which 12 million T of this coal, that in the long-term could be used for coking, is currently burned.

Thus, the main trend in geological exploratory work in the Kuznetsk basin should become the search for and exploration of sections with coals of types K and OS, with a reduction in the exploration for gas coals. At the same time the long-term plans for traditions formed in the basin provide for the main volume of work on the abundant gas coals. The development of exploratory work on coals of types K and OS not only will permit elimination of the gap between the state of their supplies and the demand for them, but also will permit involvement of greater volumes of gas coal into coking production.

Coals of types K and OS have developed only in the deposits of the Balakhonskiy series that has been studied very well in the basin, and it is difficult to expect the discovery of new large fields here. Therefore the main trend in work in the Kuznetsk basin should become a radical reevaluation of all the known (including the previously rejected) sections for the spread of the Balakhonskiy series in the Anzherskiy, Kemerovo, Krapivinskiy, Bachatskiy, Prokop'yevsk-Kiselevsk, Bunguro-Chumyshksiy, Kondomskiy, Mrasskiy, Tom'-Usinsk and Tersinskiy regions.

The outlook for the Anzherskiy region is limited, since the coal rapidly becomes lean with depth here and it is required that the expediency of exploring the thin beds of the Chelinskiy strata be clarified. In the Kemerovo region it is necessary to intensify the work at the Nizovskiy, Glusha, Yuzhno-Konyukhtinskiy fields and the West Kedrovoye area. In the northern Krapivinskiy region the outlook of the Yermak field and the areas neighboring it should be evaluated. On the eastern wing of the Kuznetsk hollow in the Bachatskiy region it is necessary to solve the question of the expediency of exploring the tectonically-complicated areas of development of the Kemerovo and Usyatskiy subseries with supplies of coals of types K and OS of more than 1 billion T. The outlook for the main industrial region of Prokop'yevsk-Kiselevsk is linked to the deep levels. In the northern Bunguro-Chumyshskiy region, where the deposits of upper Balakhonskiy subseries are distinguished by increased coal content and considerable content of vitrinite in the coal, the search and exploration work should be intensified.

One of the most promising regions in the Kuznetsk basin is Tom'-Usinsk, where on the Tomsk area, as well as the deep levels of the Ol'zherasskiy and Berezovskiy fields over 1 billion T of coal supplies of types K and OS are concentrated. The time has come to reevaluate the outlook for the Makar'yev field and Tersinskiy region that were rejected over 20 years ago. Here the possibility of a considerable increase in the supplies of coal types K and OS that are currently evaluated at 350 million T has not been excluded.

The low-ash coals type SS whose standard supplies in the Kuznetsk basin surpass 18 billion T can become an important reserve of coal for coking in the more distant future; part of them can be stripped by the inexpensive open-pit method. In the mine with metabituminous coals types SS yield coke of satisfactory quality.

The third base of coking coal in the USSR by right is the Karaganda basin with standard supplies of coal of types Zh, K, and OS of 11 billion T; of them the balance is 4.7 billion T. The basin is characterized by favorable correlations of coal supplies of different brands--over 90% of the supplies belong to types Zh, K, and OS, including over 60% to types K and OS. In the last 10 years the structure of consumption of Karaganda coal has been altered towards a sharp increase in the use of coal types Zh and KZh for coking. The output of the reserve fund explored in detail for the sections with coking coal in the beginning of 1979 was 9.3 million T. The sections that are promising for exploration hold mainly coal of types K and OS, which significantly broadens the outlook for the Karaganda basin.

In addition to the Saransk-Nizhniy section in the Karganda region, the deep levels of the Sherubaynurisnkiy region are promsing, where to the west of the active mines a major section is located with supplies of coking coal on the order of 1 billion T. The Taldykudukskiy section located in the developed region near Karaganda is also promising; supplies of types K and OS coal in it number in the hundreds of millions of tons.

In the Karaganda basin it is necessary to make a thorough analysis of the materials for all the sections rejected for different reasons and to reveal the possibility of including them in the exploration and development (Alabasskiy and Sasykkol'skiy and other sections). If one considers that the Karaganda basin is the only real base for the coking coal in Kazakhstan, then the importance of such an analysis becomes evident.

The introduction of new facilities of the enrichment plants has great importance for the basin, which will permit the involvement of the supplies of hard-to-enrich caking coals of the Karaganda and Ashlyarikskiy series, numbering many billions of tons (now these coals are classified with the fuel coals) into the sphere of coking. Considerable supplies of coals of types Zh and K are concentrated in the thin beds 0.5-0.7 m thick. Currently the drilling method of working thin beds is being introduced, which will permit involvement in future use of the beds of high-quality coking coal th that are left, in the first place, of the Dolina series (supplies of several hundreds of millions of tons).

The Pechora basin is a large base of coking coal in the northeastern European sector of the USSR; it has supplies of standard caking coal up to depth 1800 m of 10 billion T and balance supplies of 3.6 billion T. The explored supplies are characterized by the dominance of type Zh coals and a shortage of type K and OS coals. The output of the reserve fund of coking coal that has been explored in detail was 14.1 million T at the beginning of 1979. It should be noted that the sections that can be explored and are promising for exploration are represented only by metabituminous coals of types Zh 19 and Zh 10; the coals of type Zh 10 are practically not metabituminous, but gas.

The almost complete lack in the basin of explored and developed sections with coal of the scarcest types K and OS resulted in the fact that for making the metabituminous Pechora coals lean annually about 2 million T of type OS coal is delivered to the metallurgical plants of the northern European sector of the USSR from the Kuznetsk basin (the cost of the hauling is annually R 20-25 million). Therefore the main task of the geologists in the Pechora basin is to search for and explore coals type K and OS. At present the Syr'yaginskiy area is the most promising for the search and exploration of coal of these types. The outlook for the Pechora basin can be considerably broadened also by involvement in the sphere of coking of the caking coal that possesses increased ash content of the Intinskiy series, and subsequently the Pechora series also, that now are classified as fuel coals. Their supplies number several billion tons. This concerns primarily the Vorkuta field. Analogous coals of the Karaganda basin are successfully used for coke production. Major supplies of coal (many hundreds of millions of tons, and even the first billions of tons) are concentrated in the thin beds less than 0.8-1 m thick that are currently classified with the group of balance.

In the Far East the main base of coking coal is the Yuzhno-Yakutsk basin whose depths contain vitrinite coals of types K, KZh and Zh that are unique in quality. The standard supplies of the coking coal is evaluated up to depth 1800 m as 19 billion T, the balance--2.7 billion T. The output of the reserve fund that had been studied in detail was 2.1 million T per year at the beginning of 1979.

In the Aldano-Chul'man region of the basin the Neryungri field with supplies of over 500 million T contained in a bed on the order of 50 m thick has been explored and is being developed at rapid rates. However, all the other fields in the region are characterized by a lower coal content and contain 2-3 relatively stable beds usually up to 2 m thick. The most promising are the Chul'makanskiy, Denisovksiy, as well as the Berkakit field with coals type K suitable for development only by the underground method.

The main outlook for the further development of the open-pit extraction in the basin should apparently be linked to the Tokinskiy region that is located 280 km to the east of the Aldano-Chul'man region. Strictly speaking, the Tokinskiy region is an independent coal basin with large supplies of high-quality coals type Zh and K. The most promising are the El'ginskiy, Khudurkanskiy and Chertandinskiy fields with beds of total thickness 25-30 m, suitable for open-pit stripping. The fact that the basin is located 200 km to the north of the BAM [Baykal-Amur Mainline] and 300 km from the shores of the Pacific Ocean is important. If the prognostic evaluation of the basin as a major base of coking coal in the Far East is confirmed it is expedient to solve the question of extending the railroad branch of BAM Tynda-Berkakit further to the east to the Tokinskiy basin, and possibly, even to the shores of the Pacific Ocean. By the way, this region, in addition to coal is also rich in other minerals. The large areas located on the western continuation of the Yuzhno-Yakutsk basin are also promising, where the Apsatskiy field has already been found with coal type K. If the question as to the construction of a metallurgical plant in the Far East is solved positively, the Yuzhno-Yakutsk coal will be used at the site as the oily base in the burden with gas coals, for example, Bureya or Irkutsk.

The Kizel basin is located in the Urals with highly sulfurous gas and meta-bituminous coals (total supplies 0.5 billion T). There are practically no outlooks for the expansion of resources of coking coal here.

Apparently, the time has come for a serious evaluation of the outlook for the giant basins, Taymir, Tungusskiy and Zyryanka having (especially the first) large supplies of coking coal. Work in the Taymir basin, where about 30% of the supplies of coking coal in the USSR are concentrated, should be restricted to the stage of searching in order to make a general evaluation of its outlook. It will be expedient to conduct more detailed work only after questions have been answered of exporting the Taymir coal by the northern sea route. The eastern section (in the first place the Chernoyarskiy field) is the most promising in this basin; thick beds have been developed and the coal is the least subject to the effect of thermal metamorphism.

We will briefly discuss the basins that have considerably smaller supplies of coking coal.

In the Irkutsk basin the Novometelkinskiy field has been explored; it has good caking coals of type GZh in a quantity of 600 million T, however their high sulfur content (4-8%) reduces the outlook for the field; its development will be expedient only after the working out of profitable methods for desulfurizing the coal. Apparently, the possibility should be evaluated of finding low-sulfur caking coal in the basin similar to the coal of the Ishinskiy field.

The Sayano-Partizanskiy field in the Kansk-Achinsk basin contains about 1.6 billion T of gas caking coal. Sakhalin Island has insignificant supplies of coal types G, Zh, K and OS (600 million T), part of which is being developed.

Coals of types GZh, Zh and K (11.1 billion T) are known in the Ulukhemskiy basin of the Tuvinskaya ASSR. The basin is considerably distant from the Transsiberian railroad mainline and its development is not planned in future years.

In Central Asia fairly large supplies of coking coal (1.6 billion T) are known in the Uzgen basin located in the high-mountain region of Kirgizia. Coals of types K, KZh, Zh and GZh are spread in the fields of Kargasha, Tyuk and Kokkiya that are suitable for underground and drift stripping. There are several fields with type GZh and Zh coal in the high-mountain regions of Tadzhikistan. The supplies of the largest of them (Fan-Yagnob) are estimated at 1 billion T. In future years the Central Asian geologists should evaluate the outlook for these fields.

In certain basins the supplies of coking coal have been classified as fuel coal for a number of reasons. For example, in the Bureinskiy basin in the Far East the explored supplies of ash gas coals exceed 1 billion T. According to data of the Eastern Scientific Institute of Coal Chemistry (VUKhIN), these coals in a burden with coals of the Yuzhno-Yakutsk basin yield strong metallurgical coke. Therefore, in the Bureinskiy basin itself, which is located on the BAM route, and in the neighboring areas (Gerbikano-Ogodzha, Tyrma) the setting up of search and exploratory work is required. It is also necessary to evaluate the possibility of finding industrial fields of caking coal at the Deptskiy area located in the zone of influence of BAM.

In the L'vov-Volynskiy basin all the supplies of gas and metabituminous coal has been unjustifiably classified as fuel coal, despite the fact that they are currently being successfully used at the coking plants of the Donetsk basin. It is necessary to regrade this coal and intensify the exploratory work in the southern half of the basin.

Thus, the main paths for an increase in the resources of coking coal, in addition to the search for and exploration of new sections with coal of the scarcest types Zh, K and OS, consists of involving high-ash caking coal and coal contained in the thin beds whose supplies number in the billions of tons in the sphere of coking.

An important reserve for increasing the resources of coking coal is reduction in their losses both in the process of planning in the determination of the quantity of the industrial supplies, and during the development of the fields and their transporting. For several basins (Kuznetsk, Karaganda) the coal losses envisaged by the plans exceed 30-40% of the supplies approved by the USSR State Commission for Supplies of Minerals, and comprise the first billions of tons in a quantitative expression.

In addition, one should exclude the use of coking coal not for a direct purpose. In the Donetsk basin one-fifth of this coal is currently consumed for power purposes, and in the Kuznetsk and Karaganda, about one-third. In absolute amounts this is expressed in several tens of millions of tons of coal per year.

Thus, the main paths for increasing the resources of coking coal are the following:

--expansion in the exploration of the deep levels of the Donetsk and Karaganda basins; reevaluation of the outlook for the Tatsinskiy region of the Donbass and Syr"yaginskiy areas in the Pechora basin where considerable supplies of scarce coals Zh, K and OS are concentrated, as well as the outlook for the L'vov-Volynskiy basin;

--organization in the Kuznetsk basin of extensive search and exploration work on the acutely scarce coals type K and OS of the Balakhonskiy series (Tomsk area, lower levels of the Ol'zherasskiy field, southern Bachatskiy region, central Kondomskiy region, northern Bunguro-Chumyshskiy region, and Kemerovo region) by reducing the work on the areas of development of the gas coals in the Kol'chuginskiy series;

--conducting of extensive searches in the Yuzhno-Yakutsk (in the first place in the Tokinskiy region), Taymir and Bureinskiy basins;

--broad use for coking of the ash coal that is diffiult to enrich but which cakes well, that currently goes for power engineering due to the lack of the necessary facilities in the enrichment plants. The supplies of such coal in the developed regions of the Karaganda and Pechora basins are estimated at several billions of tons;

--decrease in the minimum standard thickness of the beds to 0.6 m in the Karaganda and Pechora basins, and to 0.45 m in the Donetsk basin, which will permit an increase in the coking coal resources by several billions of tons;

--expansion of the gamut of coal used for coking, and broader involvement in the sphere of coking of the gas, lean caking and dry-burning coals;

--decrease in the losses of coal during planning (by more complete involvement in the development of supplies approved by the State Commission for Mineral Supplies) and extraction;

--more complete use of the coking coal for direct purpose (currently 20-30% of the coking coal is used for energy purposes).

The fulfillment of the recommendations stated in this article will permit an improvement in the state of the coal raw material base for coking, and will provide raw material for the systematic development of the country's industry.

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